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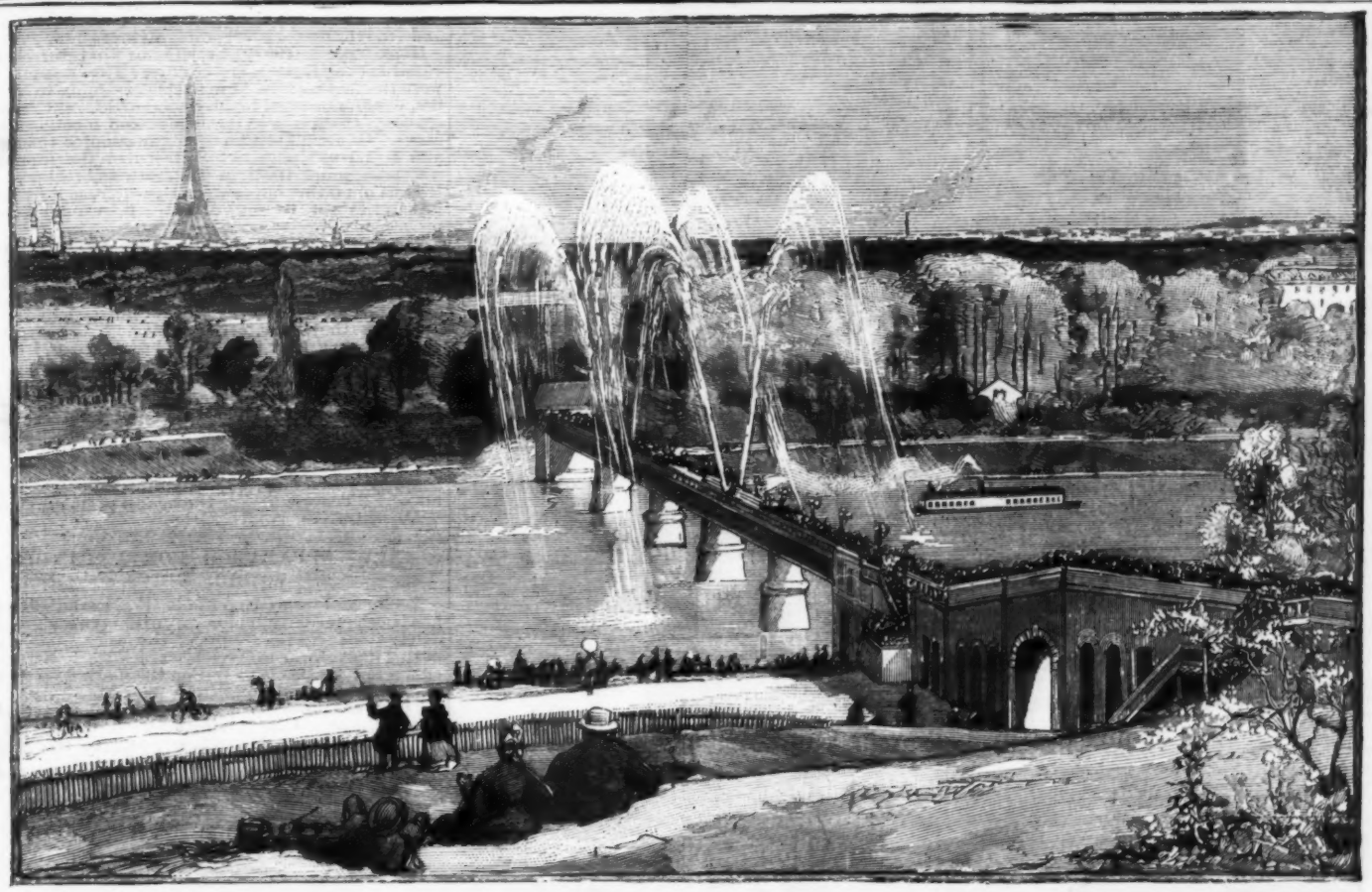
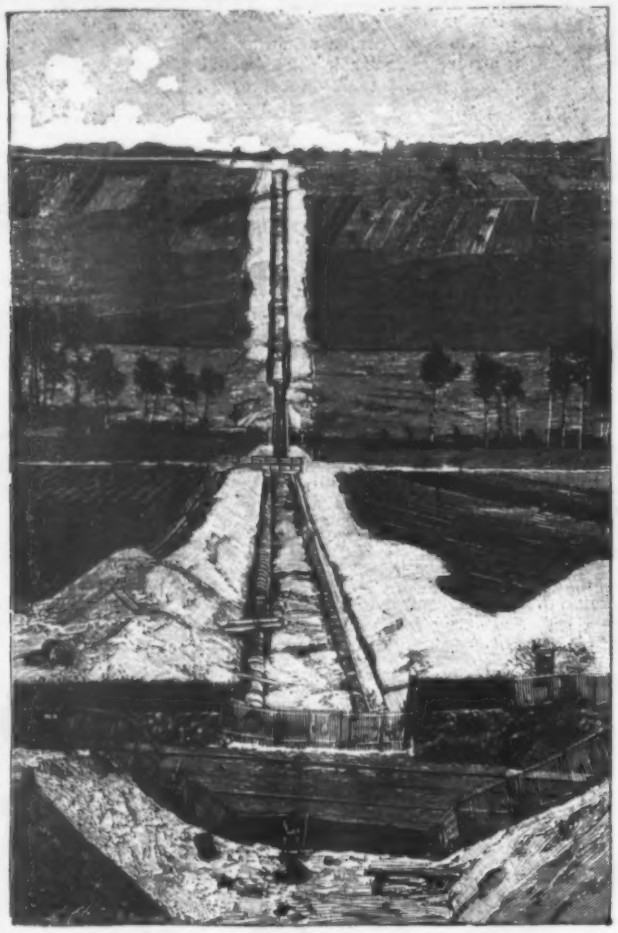


ARRIVAL OF THE WATER OF L'AVRE AT PARIS—INAUGURATION OF THE RESERVOIR AT ST. CLOUD.

THE NEW WATER SUPPLY FOR PARIS—THE WATER OF THE VIGNE AND AVRE.

THE Saint Cloud reservoir, designed for the storage of the 120,000 cubic meters of spr'ng water that the curbing of the sources of the Vigne and Avre is hereafter to send to the city of Paris, has just been inaugurated with a certain solemnity.

The remarkable characters of this important hydraulic work, which leads the water under a pressure of 70 meters across the Seine near Saint Cloud, are simplicity and economy. Under the direction of Mr. Bechmann, the engineer in chief of the city of Paris, the sources, long ago acquired, have, in two years, been curbed and brought to the gates of the capital through a huge conduit one and a half meters in diameter. Messrs. Humblot and Bienvenue have carried on the work with a precision that does real honor to our French engineers.



THE SIPHON OF THE VALLEY OF THE MAULDRE.

Our engravings represent various aspects of the hydraulic work. We see in the first place the source of Erigny (one of the most lovely that have been put under contribution) before and after being curbed. Before the curbing one might have thought he saw a very quiet and modest little pond. Who would have suspected that there were here numerous and continuous cubic meters of water in reserve? The inhabitants of the country themselves did not dream of it. After the curbing the scenery abruptly changes. The fairy of the waters has been seized by the merciless engineers and shut up in the little stone structure shown in our engraving. The contrast is striking. The poor naiad remains enchained therein like her sisters of Foisys and Nouvet that our other engravings show.

Here, too, are the great siphons that traverse the valleys of the Eure and Mauldre. The Romans, who were the first masters in matters pertaining to hydraulics, could not have resisted (and artists will regret it) crossing these valleys on slender and monumental arcades. Our engineers have simply adopted the modest and powerful siphon, which lies upon the ground like a serpent, hides itself in the earth and reappears victorious upon the opposite crest, where, as if by magic, it empties the torrents of water drawn up from the other side of the valley.

The aqueduct, on its 100 kilometers length, comprises eleven of these siphons, two tunnels and but a few arcades, these latter being at Meurette, Marigny, Poterie, Fontenay-le-Fleury, and Saint Cloud.

The task of our engineers is not finished by the success that they have just obtained. The general programme that they themselves have fixed is, it will be remembered, bilateral, that is to say, the pipe line which leads the sources of the west to Paris will soon be doubled by the construction of an analogous one to the east of Paris. The estimated total expense is seventy million francs, about half of which has just been used.

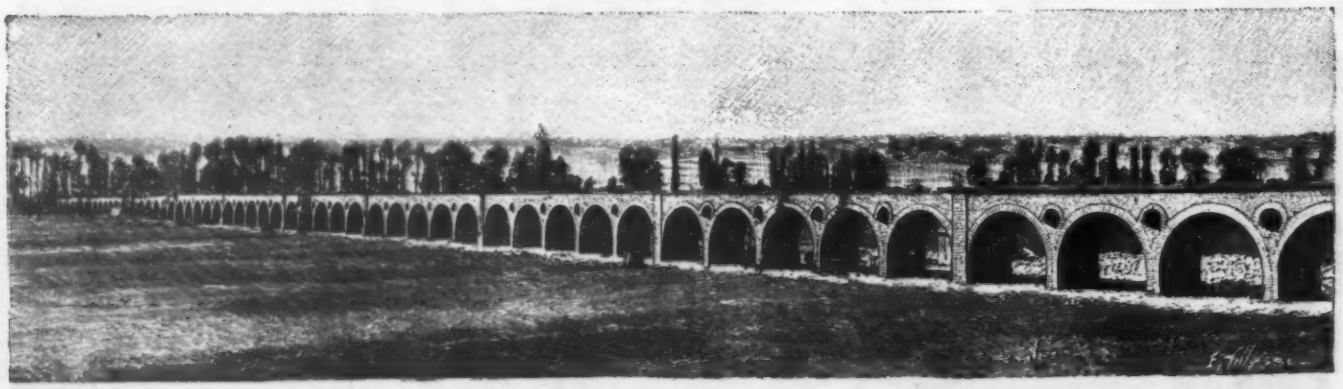
Finally, the city of Paris will find itself for some time supplied with a large quantity of that good spring water which is necessary for the health of its inhabitants. —*L'Illustration.*

NEW APPARATUS FOR EXPANDING WHEEL TIRES.

A NEW and interesting application of the Wells light has been recently made in expanding locomotive driver tires, and the results of the work done with it in this line appear to have been of a very satisfactory character. It has been put on the market by William Halpin, 46 Washington Street, New York City.

The Wells flame, as is well known, is practically a large blowpipe flame, giving a very high and yet perfectly controllable temperature, and to this fact its

THE NEW WATER SUPPLY FOR PARIS—THE SOURCE OF ERIGNY AFTER BEING CURBED.



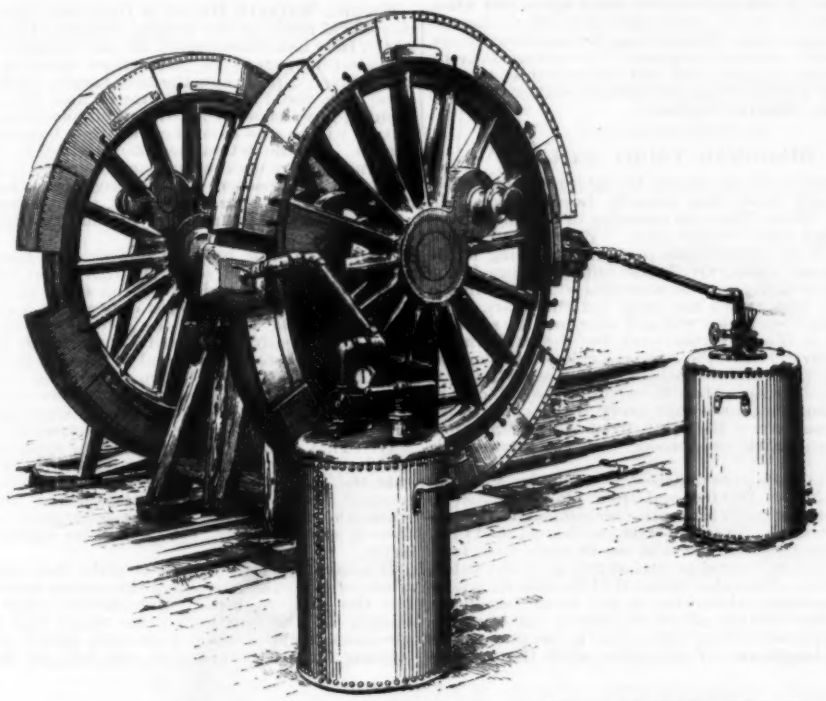
AQUEDUCT OF THE VALLEY OF THE EURE.

successful employment as a means of expanding wheel tires is, in the main, due. Just how it has been applied to this purpose is clearly shown in the accompanying illustration, which shows a tire being expanded for removal.

Two lights, it will be noted, are employed, one for heating the upper half and the other for heating the lower half of the tire. The burners are substantially the same as those used for illuminating purposes, but the tubes on which they are placed and through which the oil is fed are fitted with universal joints so that the burners can easily be made to assume any desired position.

Surrounding the upper and lower halves of the tire are sheet metal hoods, made up of several sections or segments linked together, and adjustable so as to admit of making the hoods longer or shorter, and, consequently, of applying them to wheels of varying diameters. These hoods fit over the tire, but leave spaces of the full width of the tire and about 5 in. high between its face and the top of each hood. Into these flues the flames are directed, being introduced at the gaps left between the upper and lower hoods. The burners, as will be understood, are so placed that one flame is turned over the upper half of the tire, and the other over the lower half, the result being that practically the whole tire face is encircled by the flames. The immediately apparent advantage of this arrangement is that a high degree of heat is uniformly applied, and the tire is heated quickly and evenly without giving the wheel center itself much opportunity to become hot and to expand with the tire; hence, the whole trouble of sticking, so frequently experienced, is avoided.

The rapidity with which tires can be expanded and removed from or shrunk on wheel centers by this application of Wells lights was strikingly illustrated by some work done a short time ago at the Kingsland, N. J., shops of the Delaware, Lackawanna & Western Railroad. Four ties, averaging 1⅜ in. in thickness, were removed from 57⅜ in. centers, and two new tires,



THE WELLS LIGHT APPLIED TO TIRE HEATING.

⅜ in. thick, were shrunk on 44 in. centers. The four first mentioned tires, it is stated, were removed in 59 minutes from the time of the application of the first flame to the first tire. In shrinking the two 3 in. tires on the smaller 44 in. centers it required 10 minutes to heat each tire, and in 13 minutes from the time of the application of the first lamp each tire was in position. Records were also kept of the quantity of oil used in doing this work, showing that two men can remove or adjust, on an average, four tires an hour with an expenditure for material of only 40 cents.

Added to this advantage of rapidity and cheapness should be the fact that the work is independent of the weather; it can be done in the shops as well as out of doors, neither smoke nor ashes being produced. The hoods used in the work are said to have been unaffected by the flame, and would thus appear to promise good service for a long time.

Not content with this one special application of the light, the makers point out that it can also be used for other purposes not much less important, for heating engine frames, for example, which have become bent and for straightening them while in position, and for doing other heavy work to which it is impossible or inexpedient to bring a furnace fire. Applied to bent engine frames the flames, it is claimed, will give all the heat necessary for straightening without burning the paint off or heating adjacent parts, and, in addition, will effect an appreciable saving in time. Then again the light may be successfully applied to boiler shop work in laying up laps and corners around water legs and openings, and in boiler repairs for shaping patches, heating bagged crown sheets, etc.

We understand that this apparatus has also been tried lately at the Meadows shops of the Pennsylvania Railroad.—*Railroad Gazette.*

Fatigue caused by brain-work acts as a poison. The blood of dogs fatigued by long racing also acts as a poison, and when injected into other dogs makes them exhibit all the symptoms of fatigue. Sense of fatigue seems to be due to the products of the nerve-cells rather than to deficiency of proper substance.

ALUMINUM.

*Technical Importance of Aluminum and its Future Applications.**—The general effect of aluminum when used to alloy with other metals is the increase of their ductility when small quantities are added, and of their ultimate strength when the amount employed is larger. A certain mean quantity therefore gives the most favorable results in both respects. The aluminum bronzes are the most generally useful alloys; in the following table are some figures given by Tetmajer for cast specimens:

Commercial name.	Percentage of aluminum.	Tensile strength.	Extension on 1 dm.
		Kilos. per sq. mm.*	Per cent.
Gold bronze.....	5·5	40	64
Steel bronze.....	8·5	50	52
Acid bronze.....	10	63·5	
—	11·5	80	0·2

* To convert kilos. per sq. millimeters into tons per sq. in. multiply by 0·6364.

All these bronzes are almost unaltered in air. The 8·5 per cent. alloy is that in which the increased tensile strength and the augmented extension are combined to the greatest advantage. The 11·5 per cent. alloy represents the limit at which the addition of aluminum renders the product brittle. The so-called "steel bronze," when cast, has an elastic limit of only 6–8 kilos. per sq. millimeter, but this can be raised by working to 24 kilos. with an ultimate strength of 60 kilos. and an extension of 35 per cent. This alloy has been used by the Maschinenbau-Actiengesellschaft in Nuremberg for eccentric straps, bearings, gear-wheels and similar purposes. Nails and screws have been made from it, and it has been used for the couplings of the tubes connecting steam-heated railway coaches. Bearings made from the 5 per cent. bronze wear better than those of gun metal containing 10 per cent. of tin. Hard rolled sheet with a high content of aluminum has been used for springs in such things as arc lamps. Tetmajer has also tested certain cast specimens of aluminum brass. The brass used contained 67 per cent. of copper and 33 per cent. of zinc. The results show that copper can bear a much larger percentage of aluminum before becoming brittle than brass. This is also true as regards different qualities of brass, the permissible quantity of aluminum increasing with the percentage of copper.

Aluminum lends itself to the production of decorative effects, as it may be given a dead white surface by the action of caustic soda, and gray tones can be produced by similar means. It may be readily spun, and all kinds of hollow goods prepared from sheet metal without a joint. The tensile strength of cast aluminum is about 10–12 kilogrammes per square millimeter and it has an extension of only 3 per cent. Its strength may be raised by working, and notably by rolling. It is annealed by heating and rapid cooling.

Attempts have been made to raise the strength of aluminum by the addition of small quantities of other metals. The following are the results with copper: *Tensile strength* (kilogrammes per square millimeter), 2·7 per cent. of copper added, cast, 16·1; cold rolled, 30; annealed, rolled, 20; 6 per cent. of copper added, cast, 12; cold rolled, 33; annealed, rolled, 20; 2·5 per cent of copper and 2·5 per cent. of cadmium added, cast 19. *Extension on 1 dm.*, per cent., 2·7 per cent. of copper added, cast, 13·5; cold rolled, 3; annealed, rolled, 19·5; 6 per cent. of copper added, cast, 5; cold rolled, 10 to 12; annealed, rolled, 10 to 12; 2·5 per cent. of copper and 2·5 per cent. of cadmium added, cast, 18. When 10 per cent. of copper is used the alloy is brittle in the cast state, but loses its brittleness on working, and is fairly hard, while its specific gravity is not raised much above that of pure aluminum, being 2·9.

* Herr J. Klandy, *Mit. Tech. Gewerbe-Museums*, 1898, 89-101, thro' *Jour. Soc. Chem. Ind.* of March 31.

Aluminum is troublesome to cast, forming blowholes freely, a defect which Coehn has attempted to remedy by the addition of sodium. The electric conductivity of aluminum is only 59 per cent. of that of copper, in spite of which it might be used for field telegraph purposes on account of the saving of weight. The conductivity of aluminum bronze is too low to allow of its use for telegraph or telephone lines, for which purpose it is otherwise well suited on account of its high tensile strength. Pure aluminum, when cast, shrinks about 1·8 to 2 per cent.; the shrinkage is diminished by the addition of 8 per cent. of copper. The loss by oxidation on remelting is about 2 to 6 per cent. The problem of soldering aluminum satisfactorily is not yet completely solved. Taking the present price of aluminum at 3 fl. per kilo. it is volume for volume 164 per cent. cheaper than nickel, 11 per cent. cheaper than tin, and only 20 per cent. dearer than copper.

The Oesterreichische Alpine Montangesellschaft uses a 10 per cent. ferro-aluminum in quantities of 0·25 to 0·5 per cent. as an addition to Siemens-Martin steel of special quality. The action is a double one. The steel-bath is quieter, and blowholes are almost wholly removed. The addition of ferro-aluminum is not found necessary for crucible cast steel. The addition of aluminum has also been practiced by the Witkowitzer Bergbau- und Eisenhuttengewerkschaft for producing sound castings with success. The additional cost is quite trifling. The attempt to use aluminum as a substitute for ferro-manganese in the converter or in an open hearth furnace is rendered nugatory by the lightness of the metal causing it to float on the surface of the bath, and there burn uselessly. If added to the metal in the ladle the surface becomes honeycombed in an inexplicable manner, so that the use of aluminum is restricted to the removal of comparatively small evolutions of gas in place of silicon, which has long been used for quieting the metal and getting sound castings.

As regards the prevention of blowholes in copper, phosphorus appears better suited than aluminum. It is stated that according to the experience of the French navy aluminum brass containing 2 per cent. of aluminum has been found to resist the action of sea water, and to be the most suitable metal for the sheathing of ships. Nemetz has made many experiments on the suitability of aluminum for the beams of analytical balances. Rolled aluminum sheet has long been used with success, but these later experiments were with cast metal. Pure aluminum was too weak, and the alloys containing copper had a tendency to form cracks during stamping. The best results were obtained with an alloy of aluminum containing 3 per cent. of fine silver and 2 per cent. of chemically pure copper, the casting, after being diminished in cross section about 0·2–0·3 millimeter by pressure, being hard and springy, free from cracks, and showing no tendency to flexure until severely overloaded. The surface could be polished with very fine emery paper and oil, but with other polishing agents a rough, porous appearance was produced, although the metal was really free from pores. The alloy retains its condition better than ordinarily gilded beams, even after having been in use for years. When aluminum is cast a second time a certain quantity of fresh metal must be added to avoid the formation of blowholes. Aluminum can be made into tubes by the Mannesmann process.

The future applications of aluminum depend mainly on its price. There appears reason to think that the actual cost of manufacture cannot by the present processes fall much below 1·5 fl. per kilo. The author compares the cost of its production with that of iron. He finds that the price of the raw material is eight times as great as that of iron for a given content of the metal. He calculates that the capital expenditure necessary per ton of aluminum is about 56 times as large as that requisite for an iron works. The cost of energy, even allowing the use of water power, is about three times what it would be for iron. In addition to this an expenditure of 0·15 fl. per kilo. of aluminum is necessary for the carbon electrodes used. From these figures it results that aluminum must be 67 times as dear as iron without reckoning the cost of the electrodes, that is, taking pig iron at only 0·2 fl. per kilo. the manufacturing cost of aluminum would be 1·34 fl. per kilo., or with the addition of the 0·15 fl. for electrodes mentioned above, 1·49 fl.

*Progress of the Aluminum Industry.**—A comparison is drawn between three 10 ton displacement sailing yachts built of wood, steel and aluminum, respectively. For the same strength the aluminum yacht will have less than half the weight of the others. This will mean a larger amount of ballast, in order that the displacement may be the same, and a corresponding lowering of the center of gravity. Thus in the wooden vessel the center of gravity will be 0·43 meter, in the steel vessel 0·47 meter, and in the aluminum vessel 0·65 meter below the water line. The stability of a vessel is greater the lower the center of gravity, and the sail area is proportional to the stability. For the three yachts in question the sail areas will be in the ratio 1 . 1·06 : 1·35, and as the speed is proportional to the square root of the sail area, this value for the three will be in the ratio 1 : 1·03 : 1·16. For the same displacement, then, the aluminum yacht is much the fastest. The ratio of cost may be approximately stated as 1 : 1 : 1·8, but from this last figure must be deducted the value which the worn-out hulk of the aluminum yacht will still possess.

Great advantage as regards weight is claimed for the use of aluminum framework for the windows of railway coaches; it should also be employed for parts of sewing machines. An alloy of aluminum with 17 per cent. of copper is recommended for slide valves. For glue, gelatin and wax boiling and melting pots, aluminum has the advantage that it does not discolor the products, as do iron and copper, by forming colored sulphides with the sulphur in the glue, etc. An alloy of aluminum with 6 per cent. of copper is employed for watch cases in the Swiss watch industry. Lithographic stones and composing sticks of aluminum have been patented. A large number of small articles such as penholders, billiard cues, etc., are made of aluminum by the Mannesmann method of tube rolling.

Aluminum bronze is being extensively used for marine and torpedo work; it has a lower specific grav-

* *Dingl. Polyt. Jour.*, 1898, 284, 253-255, thro' *Jour. Soc. Chem. Ind.* of March 31.

ity (7·7) than any other non-rusting metal (phosphor bronze = 8·9). The "double bronze" wire for telephonic use is an aluminum core with a copper sheathing, its breaking strain is 76 kilometers per square millimeter, and its conductivity is 60 per cent. of that of copper, which is better than silicon bronze of the same strength. The 5 per cent. bronze is well fitted for the ignition tubes of gas motors, on account of its resistance to oxidation at high temperatures; according to H. Schiff it is 17·6 times less oxidizable than copper, when heated in oxygen, apparently because the layer of oxide first formed does not scale, and thus protects the metal beneath. The 12 per cent. bronze has been used for some time for the needles of percussion caps.

With respect to the addition of aluminum to steel J. O. Arnold states that he has observed a temperature rise of more than 100° immediately after the addition, and is of opinion that the freedom of the casting from blowholes is due in great measure to the reduction of dissolved carbon-monoxide by the aluminum.

He has passed this gas over red hot aluminum and obtained alumina and carbon, and by passing carbon-monoxide through a molten steel containing aluminum he has raised the carbon content from 0·30 to 0·51 per cent. The addition of aluminum is recommended for all castings which are to stand pressure, and is effected as follows: The aluminum ingots are heated in a small ladle and some iron allowed to flow on to them; these are mixed until the mixture begins to solidify, whereupon the mass of the iron is run into the casting ladle and the aluminum alloy immediately poured in; 200 grammes of aluminum per 100 kilos. of iron are recommended. The casting is not made immediately after the addition of the ferro-aluminum, but as soon as a thin scum makes its appearance on the surface of the metal, which by this time will have cooled to orange yellow. The reason for thus waiting is probably because the contraction of iron containing aluminum is greater than that of ordinary cast iron, so that the more nearly the temperature approximates to the solidifying point when the casting is made, the better this will be.

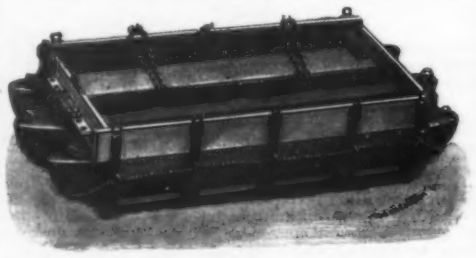
THE VIKING SHIP.

THE Viking, as the model of the old Viking ship discovered in 1880 near Sandefjord, Norway, is called, has just sailed from Christiania for America, where, if all goes well, she will be exhibited at the Chicago Exhibition. She will put into most of the towns on the Norwegian coast, and sail direct from Bergen about the 22d of April. Her commander, Magnus Andersen, and the second mate, Christian Christensen, in 1886 attempted to sail in a little open boat, 19 feet in length, called the Ocean, from Glasgow to New York, but, when within 270 miles of Newfoundland, after having lost almost everything on board, including their nautical instruments, they were compelled to give up and seek shelter and safety on board a British ship and return to Europe. The experience thus gained will doubtless prove of good service in sailing the Viking across the Atlantic, a feat, however, which must be attended with very considerable risk, notwithstanding that the commander and crew, twelve men all told, are picked seamen. The Viking is an exact copy of the old vessel, and is splendidly built of the best materials, but even the work on her, modern as it is, in no way surpasses that of the original. The voyage will be no child's play. The huge lug sail will have to be watched with care. It has been made in four parts, laced together, and reefing consists in removing one portion and lowering the sail accordingly. It has been presented to the vessel by a Glasgow firm. The men will have to sleep on the bottom boards as best they can. Cooking will take place on a modern stove inclosed in a small iron caboose. Provisions are carried in tinned iron cases. She carries a drogue, or sea anchor, and oil bags to protect her in a breaking sea. All decorations, such as the shields, dragon's head and tail, will be stowed away, and two buoyant fenders fixed along the sides. The rudder, which is placed at the side, proves quite as effective as a modern one shipped aft. Her departure took place in magnificent summer weather, and was witnessed by one of the largest crowds ever assembled at Christiania.—*London Daily Graphic.*

PARRATT'S DECK SEAT SAFETY RAFT.

ALTHOUGH a good number of devices have been introduced from time to time with the object of providing safety rafts or lifeboats easy of transport and manipulation, very few of them have possessed sufficiently distinctive merits to recommend them to the notice of shipowners.

The invention which we now illustrate consists of three copper pontoons which serve as deck seats when separate. The center pontoon has folding gratings on each side, and is fitted as a lifeboat with self-relieving



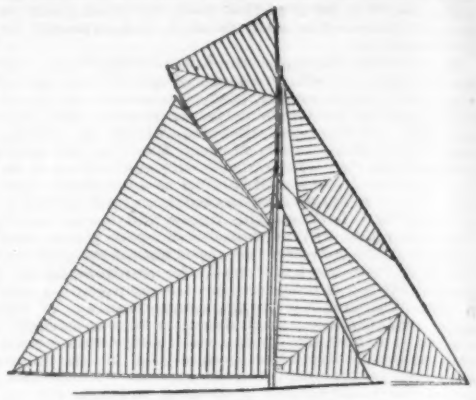
valves. There are lockers for provisions and distress signals, and a water tank under the flooring. The raft is completed by fixing the gratings in a horizontal position, and then the side deck seats are clamped underneath. Rowlocks are fixed on the wash boards. The pontoons are all on casters, and therefore the raft is ready in two minutes for launching. The conspicuous advantage of this arrangement is that the raft can be stowed away in a comparatively small space, and when the parts are in use as deck seats they are no incumbrance to the vessel. The raft can be launched in any weather with one rope attached if the ordinary davits are otherwise engaged, and will accommodate a larger number of persons than an ordinary boat of the same dimensions.—*Marine Engineer.*

DIAGONAL YACHT SAILS.

YACHTSMEN will no doubt be interested in a new diagonal sail which has recently been patented in England. Dixon Kemp, in speaking of the new invention, among other things says: "There is no doubt that one of the chief bothers of yacht sailing is the stretching and taking up of sails, but stretching is the worst, and nothing is more annoying in racing than a sail which has grown too large for the spars. The bellying has been pretty well got over, and the sail now sets as flat as the proverbial card, but the stretching is as bad as ever. Until the sail area rule of rating came into use this was not of much consequence, as the spars could be made longer than the edges of the sail to allow for stretching, but now that every inch is measured, the sail must cover the spars from end to end from starting, and little or nothing can be allowed for stretching.

"Diagonal sails were patented years ago by Matthew Orr, Kipping & Pittard, and their plans are still in use, but none of them hit on the arrangement of cloths as just patented. In the new patent it is claimed that, by their arrangement, the sails can be made to fit from the start, and will stand as well at first as at any subsequent period. This also means that the sails do not require a continual stretching to get them into shape, and that they will not afterward stretch out of shape. The principal stretching takes place in the direction of the warp lengthwise of the cloths, while there is very little stretching in the direction of the weft, the threads which cross the warp. The shrinkage in the direction of the weft is also much less than in the direction of the warp. By the new arrangement of cloths the weft runs parallel to the foot of the leach, and they claim that the arrangement is suitable for all descriptions of fore-and-aft sails."

It is whispered that some of the big English racers now under course of construction will be fitted with sails of this description, and if this is so the owners of



NEW DIAGONAL SAIL.

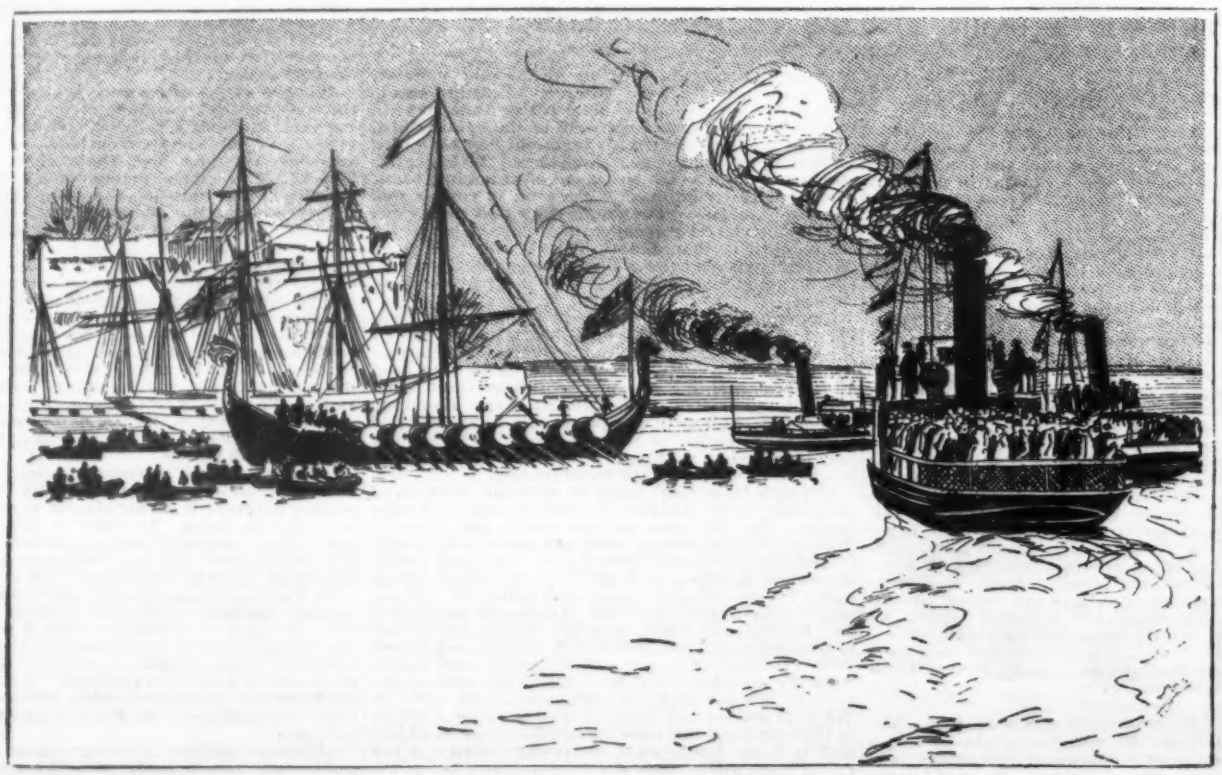
the cup defenders should not be caught napping.—*N. Y. Sun.*

THE FASTEST PADDLE STEAMER IN THE WORLD.

MESSRS. WILLIAM DENNY & BROTHERS lately made the official trials of the paddle steamer Leopold II., which they have constructed for the Belgian government to take part in the mail service between Ostend and Dover. Up till now the two vessels built by the same firm, the Princess Henriette and Princess Josephine, have earned the title which heads this article, but, as will be seen from the trial, they have now been beaten. For the determined efforts which the Belgian government are making to place their line in the very best possible position for meeting cross channel requirements they deserve all credit, and compare favorably with any other lines carrying out that description of traffic.

They have now built, including the Leopold II., within the last five years, six high speed vessels, of which the slowest has done a mean speed on service of 19 knots, and have still to get delivery of a sister ship to the Leopold II. from the John Cockerill Society, Limited, of Searing, the results of the trials of which vessel are expected to be equal to those of the Leopold II. The trials to which this vessel were subjected were somewhat severe, consisting of two consecutive double runs at full speed between the Cloch and Cumbrae Lights. The builders were restricted in every way. They were obliged to begin the trials at a certain hour, so as to eliminate any possible advantage of tide, the engine handles had to remain absolutely untouched during the whole continuance of the trials, while the temperature of the engine room, temperature of stokehold, etc., etc., were also taken into account.

It is satisfactory to be able to state that during the whole of this exhaustive trial the engines worked without the slightest hitch. Immediately after the conclusion of the fourth run the vessel was taken to Greenock, shipped some more coal, which was lying waiting for her there, and at once left for the meas-



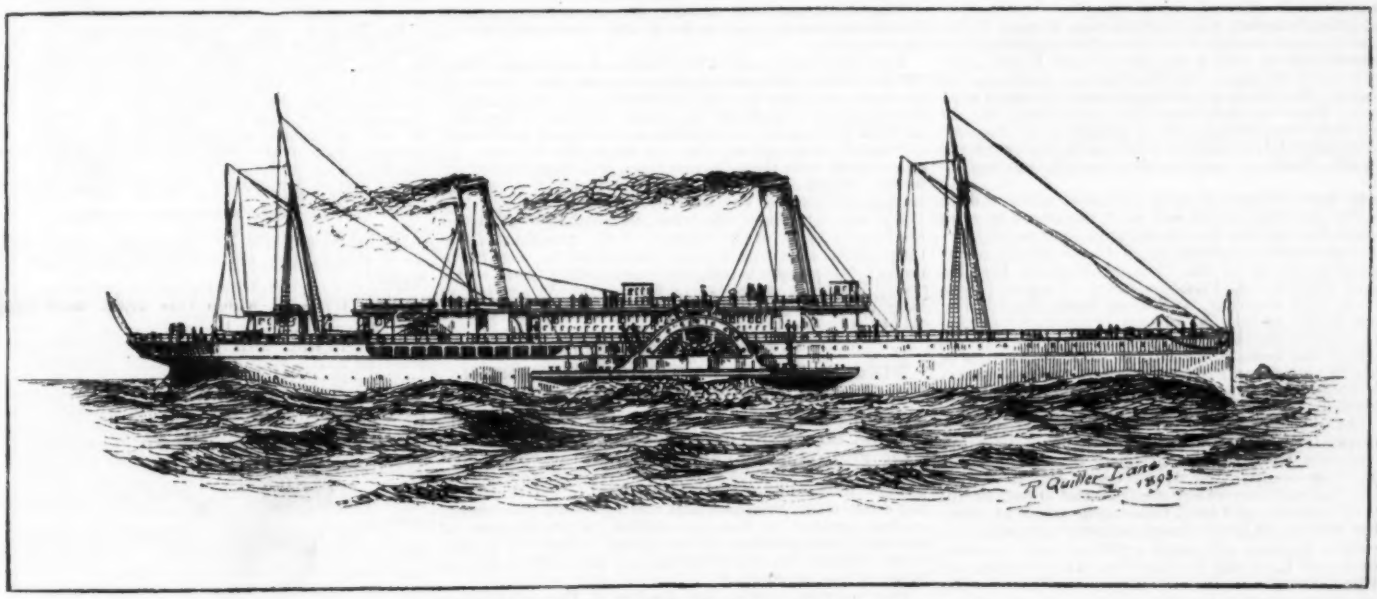
THE "VIKING SHIP" LEAVING CHRISTIANIA FOR THE CHICAGO WORLD'S FAIR.

ured mile, where a further series of high speed runs to check the accuracy of the Cloch and Cumbrae trials were undertaken.

It is most gratifying to the owners and builders to be able to announce that the mean speed was 22·16 knots, thus undoubtedly placing the Leopold II. in the position of being the fastest paddle steamer in the world.

The trials were watched on behalf of the Belgian government by the following gentlemen: Mons. Verbrugghe, directeur; Mons. Ecrevisse, inspecteur, Chief de Service; Mons. Lecointe, ingenieur en chef; Mons. Waefelaer, Commandant du Navire; Mons. Pierrard, ingenieur de la marine; with whom was joined Mons. Davin, chief engineer of the vessel. These gentlemen have expressed themselves as very highly satisfied in every way, and have, it is understood, sent a most flattering report to their government, who have to pay to the builders a very handsome premium for excess of speed, which by contract was fixed at 21½ knots.

The steamer is 340 ft. long by 38 ft. beam, and 14 ft. 6 in. deep, being 40 ft. longer and 1 ft. deeper than the steamers Henriette and Josephine. Her fittings for passengers are of the most luxurious description, far surpassing any steamer at the present moment engaged on Channel service. The restaurant is placed aft, and is capable of dining at one time nearly 100 people. The joinery and cabinet work is most tasteful, and is skillfully adapted to the shape of the ship. Owing to her fineness aft, a species of arcading has been adopted for the sides of the saloon, the pillars being of solid satinwood, carved, while the background is formed of lincrusta, painted bronze. Large numbers of small tables fitted with revolving chairs afford the necessary dining accommodation. The upholstery in this room is of very fine pattern of moquette, and all cushions are spring stuffed. A broad stairway leads down into the gentlemen's saloon below, which is of pine, painted in delicate shades of pink and cream. This apartment is upholstered entirely in buffalo hide and is heated by a system of steam coils. Another stairway leads from the restaurant to the companion house on the flying deck, which also affords shelter in rough weather, and is finished in polished teakwood.



BELGIAN MAIL STEAMSHIP LEOPOLD II.

At the fore end of the saloon there is a very handsome sideboard communicating directly with the pantry, which again is in communication below with the pantry for the gentlemen's saloon, and further below again to a large wine cellar. Forward of this pantry, and having access both from the saloon and side alleyways, is found the ladies' boudoir, finished in polished sycamore and lincrusta, with Genoese velvet upholstery and Axminster carpets. A stairway leads from this room to the lower deck, where there is provided a very large ladies' sleeping saloon, having attached to it a lavatory and a stewardess' room.

The second class is berthed forward, having separate saloons for ladies and gentlemen, while forward of this again are the crew and firemen. In the forward part there is ample accommodation for the petty officers, etc. Upon the flying deck there is a long deckhouse containing a large number of private cabins, which affords at the same time splendid shelter against bad weather; this shelter is generally wanting in other channel steamers. This deckhouse extends for more than one-third of the vessel's total length, and contains ten private cabins of large size and a smoking room, which is very well finished in teak marqueterie and upholstered in buffalo hide. At the aft end of this deckhouse the breadth as well as the height is considerably increased for the special saloons for his Majesty the King of the Belgians.

The day saloon is really a magnificent apartment. The cabinet work is entirely in satinwood and walnut elaborately carved; the roof is an intricate pattern, which has a very fine appearance, being tastefully painted and gilded. The furniture in this room is all movable, resembling more a drawing room on shore than a ship's cabin. The carpet is Axminster and the upholstery is all in a very rich silk, with curtains to match. In this room there is a small dining table and sideboards with complete arrangements. Opening off this saloon through stained glass doors there are two sleeping cabins, which may be made into one by simply withdrawing sliding doors. The joinery work of this is also of polished hardwood, with large gilded lincrusta panels, the whole forming a suite of rooms the like of which, we venture to say, is not to be found upon any steamer at present afloat.

Upon the flying bridge there is placed the steering house and the captain's room. In the steering house is placed one of Brown Bros.' patent telemotors, communicating with one of their patent steam tillers, which is located aft in the counter of the vessel, in a special compartment, which may be either entered from the saloon through movable panels or from the upper deck. A second steam steering station is placed aft, having also hand gear supplied by Messrs. Brown. During the trial the working of this gear was the admiration of all practical men on board, the ship steering, at upward of 22 knots, with the utmost facility. A bow rudder is fitted, which is actuated from a steering gear placed on the bridge deck. Lengthened trials of this gear were made after completing the measured mile, the aft gear being brought amidships, the forward gear uncoupled and the vessel being then driven full speed astern, she was easily steered by this deck gear.—*The Engineer.*

THE ELECTRICAL TRANSMISSION OF POWER.

By CHARLES J. H. WOODBURY.

THE following paper on "Recent Developments in the Electrical Transmission of Power," by Charles J. H. Woodbury, was read before the New England Cotton Manufacturers' Association, April 20, 1893:

Since the last meeting of this association, the board of government, recognizing the importance to the cotton manufacturing interests of questions pertaining to the electrical transmission of power, and foreseeing the greater importance which this method is likely to assume, have thought it advisable to continue the consideration of this subject at the present meeting; and in accordance with their invitation I beg to deviate somewhat from my former papers on electrical subjects, and instead of confining myself entirely to practical results, to give a little attention to some of the main principles involved, which will soon be as necessary a part of the knowledge of every manufacturer as the principles involved in water wheels and steam engines are at the present time.

In the ordinary dynamo for electric lighting, each of the various coils of wire making up a section of the armature is brought into the circuit as its commutator bar comes in contact with the brush, and in that manner contributes to the circuit for electric lighting or power the current of electricity which it has produced by being pulled across the attraction of the magnets of the dynamo.

In the reverse manner, if electricity were applied to such a dynamo, it would energize the magnets, pass through the wires of the armature, and the attraction of the magnets would cause this armature to revolve, or convert the dynamo into a motor, because the magnet attracts each coil of the armature, and as it moves around to proximity to the poles of the magnet, the electricity is switched out of such coils by the commutator, and the magnet exerts no further attraction upon that coil, but is ready to exercise a similar attraction for the next section, for it must be remembered that the attraction which the magnet exerts is not upon the wires of the armature, for they are made of copper, but upon the current of electricity conveyed by these wires.

A current of electricity is subject to magnetic attraction similar to iron, as may be seen by applying a magnet to a lighted incandescent lamp. The carbon filament is readily bent as if it were a very fine iron wire, but if the lamp is not lighted, the carbon filament is not affected by the magnet.

The question naturally arises, why should not iron or steel wires be used in the armature? The one sufficient reason is that the magnets would attract a section of wire in the armature and would hold it stationary. Whereas, when the attraction is exerted upon a current of electricity in the coil of wire in the armature, that principle can be used to produce a motion by the ready manner in which the electricity can be conducted through or removed from any coil of iron in the armature to meet the mechanical necessities of the case to produce a rotation of this armature.

I have gone into this matter at some length in order to state the principle of the ordinary continuous current motors, which is that the magnet remains stationary, and that the electrical currents are moved from one set of wires to another in the armature as occasion requires.

In the dynamo the electricity is generated in the armature in currents passing to and fro, first in one direction and then in the other, forming what is known as the alternating current. The function of the commutator and the brushes upon a dynamo is merely to convert this alternating current into a continuous current. There is no reason why an alternating current is not just as well suited for electric lighting as a continuous current.

But many years ago, when Sir Frederick Siemens, one of the pioneers in the application of electricity, made a dynamo for arc lighting, he required a continuous current to operate the regulator in the upper part of his arc lamps, and instead of trying to invent a form of regulator to feed the carbons, which could be operated by an alternating current, he placed the commutator and brushes on the dynamo, producing a continuous current, and in that manner set for years the practice of electric lighting by continuous currents, although in the meantime there have been numerous devices for regulating the carbon-feeding mechanism of arc lamps by alternating currents.

Electricians have of late years begun at the place from which they were diverted a number of years ago to investigate and apply alternating currents for lighting and power purposes. These investigations have opened up a wealth of electrical principles and applications of which the world has but just seen the beginning.

One of these new forms of alternating currents is what is called the multiphase current, of which the electricity is generated in waves; one wave following another before the first wave has been completed, using currents of electricity which will affect other apparatus by induction through space and without the intervention of metallic conductors, being, as a matter of principle, comparable to the results produced upon a telephone system when it receives by induction the noise of electric motors or the click of the messages transmitted along telegraph wires in juxtaposition to the telephone wires, or even the voice which is transmitted over other telephone wires.

In its application to these multiphase motors I would say that the method of construction differs entirely from the motors hitherto in use. Instead of using commutator and brushes to transfer electricity from one part of the armature to the other, as has been already alluded to in the continuous current motors, the magnetism revolves through the magnet, causing the armature to revolve in exact synchronism with it.

For purposes of comparison the general arrangement of these motors may be compared to that of a hat rim, as representing the circular magnet, and a ball of twine standing for the armature on inside, which is a suitably wound collection of insulated wires joined together at the ends and not electrically connected to anything else. Electric wires from the generators are wound upon this circular magnet, and the wave-like currents which the wires carry produce similar magnetization traveling around and around through the magnet, and by this inductive effect to which I made allusion electric currents are produced in the wires of the armature, so that it will be susceptible to the attraction of the magnet. The wires in the armature revolve, following the attraction of the magnetism circulating in the magnet.

Dynamos similar in principle produce the waves of current which supply this motor, but for economy in transmission, both as regards the small amount of wire and the small loss by resistance, these currents can be generated at a high electrical pressure, which is increased by transformers for the main wires, and then at the motors reduced to a very low pressure by transformers, which answer the same purpose as the reducing valve for steam, except that they can act in either direction to increase or reduce the electrical pressure.

The other advantages of these multiphase motors are that, being without any brushes or commutators, there is no sparking. There is hardly a possibility of a burned armature. The motor being operated by a succession of wave currents, will keep at a speed comparable to that of the generator as long as it can keep up. If overloaded, it will not run slower, but will stop. Under similar conditions of overloading, a continuous current motor will burn its armatures unless defended by its safety fuses. Its regulation is very close; the variability of some tests being only one and one-half per cent. between no load and its full load. Such a motor will start under its full load or even greater.

In connection with such a system of electrical transmission of power it is feasible to use a portion of the

current for incandescent lighting without any interference. These motors can be stopped and started without the exercise of any particular skill, and can be inclosed for protection against dust and dirt in a case which merely allows for the protrusion of the shafting carrying the driving pulley.

These types of motors, although new, have received thorough application and exhaustive tests in the works of the electric companies engaged in their manufacture. It is, however, scarcely time for their use in commercial lines in this country, but they will be very fully exhibited at Chicago.

It is this type of electrical apparatus which will be used in transmitting the power from Sewall's Falls on the Merrimac River, about four miles north of Concord, for power and lighting throughout the city of Concord, and also to any establishments which may be built on the large tract of land in the vicinity owned by that company. There is a capacity of 5,000 horse power at this point, and it is expected that 3,500 horse power will be distributed during the early summer.

The uses of electric motors in connection with the transmission of power are becoming more widely extended, one of the best examples in this vicinity being that of the Page Belting Company, at Concord, N. H., where the power is distributed throughout their extensive new establishment by means of electric motors, for which the electricity is generated in the original works of this company. George F. Page, the president, informs me that the whole cost of the electrical apparatus was 20 per cent. less than would have been required for a steam plant applied in the usual manner. There is a further economy by reason of the elimination of much of the shafting required in connection with the transmission of power from numerous motors in comparison with the shafting and pulleys which would have been required to distribute the power from a steam engine on the premises. The largest shafting now in these works is 2½ inches in diameter; but if an engine had been used, the main shafting would necessarily have been at least 5 inches in diameter, and the length of shafting many times greater than at present, the difference in this respect being greater than in cotton manufacturing, on account of the greater distance between the various machines.

In addition to safety and convenience, it may be interesting to note that this method of transmission has been carried out in such a way that there is not a single open hole through the floor for any purpose, the openings for the steam pipes being packed around with asbestos. This transmission of the power from the old works is only temporary, as it is proposed to connect with the electrical power derived from the water wheels at Sewall's Falls as soon as that installation is completed.

I have been informed that at a new cotton mill in South Carolina the power will be transmitted by wire to a motor driving the line shafting in each room.

One of the latest applications of the electrical transmission of power is in the Crocker-Wheeler Electric works at Ampere, N. J., where a pair of copper rods answer as line shafting, and from them the connections are made at will to motors operating machine tools in various parts of the establishment. In some instances it has been preferable to drive short lines of shafting by motors and to belt down in the usual way. In the former case the motor is attached directly to the machine, as for example under the headstock of a lathe, and in place of using the cone pulleys for variation in speed, or the clutch for reversing the direction of the motion, the lathe is controlled by the operator in a manner comparable to the usual way in which the motorneer of a street car controls the speed or direction of the car; and from these same wires at every machine an incandescent lamp, suitably protected by wire guards, is used whenever artificial light is necessary, and such light can be placed on the carriage, or wherever it may be desirable to apply the light for the purpose of the work in hand.

The operation of a calico printing machine probably presents the greatest difficulties in the application of power of any machinery in textile manufacture. The machine must be driven at will with variable speed, and any shock in the gradations from one speed to another may impair either the machine or the product. The cloth must be moved at times to a slight extent in either direction, and the whole must be absolutely under the control of the operator. As an absolute statement these requirements are almost an ideality. Up to the present time a double cylinder steam engine to each machine has furnished the best method of driving, notwithstanding that the heat and the floor area occupied by the steam engine is necessarily an interference in the printing room. When the printing machine stops the rolls sink into the blanket and it requires an excess of power to start it, as if it were a heavily loaded team on a soft road.

A recent application of electric motors has given practical results of the greatest importance in operating printing machines at the Dunnell Print Works in Pawtucket. At the time of their reconstruction after their late fire, about two years ago, W. W. Dunnell, wishing that the new print works should contain all of the improvements possible in the business, considered favorably the suggestion that electric motors should be tried for the operation of printing machines. A motor was applied to a 7-roll printing machine in order to give the matter a thorough trial.

This work was undertaken in spite of the skepticism of his associates and the opposition of the men engaged in the printing room. There were some difficulties at first, primarily owing to the fact that the electricians were not calico printers, as well as that the printers were not electricians. It required a little time for each to learn of the other; but since the several modifications in the arrangement for this work were introduced, the operation of the system has been not merely satisfactory but has given results in advance of any other method of driving a printing machine.

In the electric lighting station of the works an Edison lighting dynamo with a separate exciter is used for generating a current to drive a motor which was placed on the unused portion, next to the rail, of the mezzanine floor, or what is known in the printing room as the platform. For speed and direction it is controlled by a hand wheel and switch at the front of the printing machine.

This device has had a practical trial of eighteen months' duration with the most satisfactory results. By its uniformity in rotation the cloth is printed at 50 per cent. greater speed than with the steam engines in the same room. The driving is under absolute control. The cloth can be moved at will for a short distance, as an inch, if necessary. There is an absolute gradation of speed from one velocity to another, and that without any shock. These changes are so uniform that the doctor never cuts into the copper roll. The speed can be kept uniform at any desired velocity, and the machine can be stopped and started by anybody working at it. In its operation it does not require the exercise of any technical skill.

I have alluded to the maximum speed as 50 per cent. greater than with the steam engine. The uniformity of its motion can be seen by any one watching the machine, particularly in the absence of the chattering of the gears. All printing machines are necessarily still for changing of rolls and other purposes a portion of the time, but the whole production of this machine is more than 33⅓ per cent. greater than that of the machines driven by steam. When it is considered that a print works plant is worth more than $50,000 per machine, the value of a device which will increase the output one-third is sufficient to introduce radical changes in this line of manufacturing.

Mr. Dunnell stated to me that his experience, as shown by this trial, has revealed such facts in regard to the capacity and capability of the electrical transmission of power for print works that if one were to begin anew the construction of such works, he should advise instead of the numerous steam engines about the premises the generation of all the power at a central source, and its transmission throughout the establishment by electricity.

This use of motors for the operation of printing machines is the first practical instance of its kind, and its adoption and persistent and faithful trial confirms the enterprise of Mr. Dunnell, and also reflects great credit upon the practical skill of Sidney B. Paine, the manager of the mill power department of the General Electric Company, notwithstanding that his modesty prompts him to disclaim the whole solution of the problem in which he was the moving spirit, and ask for due credit for his able coadjutors.

The whole tendency of later invention in regard to electric motors appears to be in the successful use of large motors.

The Baltimore and Ohio Railroad are to use three 120-ton electric locomotives for carrying the trains in the tunnels under the city of Baltimore, being able in that manner to perform the same service in traction as with the largest locomotives and without producing any smoke to interfere with the air in the tunnel. In connection with these locomotives is a supplementary motor, which produces an air pressure for the air brakes and also for the whistle.

The advantages of electrical transmission of power are largely those of the relation of the position of the machinery with the motive power of the establishment. Each room is entirely independent from other rooms, and any motor is always ready for service as long as the machinery from which it derives its electricity is in operation.

NIKOLA TESLA AND HIS WONDERFUL DISCOVERIES.*

NIKOLA TESLA has been called by scientific men, who do not award praise freely or indiscriminately, "the greatest living electrician." At the recent convention of electricians held in St. Louis, a well known electric journal issued daily bulletins or "extras" giving a list of the delegates and distinguished attendants as they arrived at the convention, a programme of the day's proceedings and a special article of immediate interest having reference to the current discussions of the convention.

One evening during the session of the convention Mr. Tesla lectured on some of his recent experiments. The bulletin for that day contained a brief account of his life. So great is the interest taken in this young man that over four thousand copies of the journal containing this biographical sketch were sold upon the streets of St. Louis—something unprecedented in the history of electrical journalism—and in the evening his lecture, in the Grand Music Entertainment Hall, was listened to by a larger audience than had ever been gathered together before in the United States on an occasion of this kind. Many were glad to purchase the complimentary tickets at $4 or $5 apiece.

It is singular that this remarkable man should have come to us from one of the smallest and least known nations of Europe, Montenegro; that he is a young man (only thirty-six years of age), and that the best scientific minds believe he has only begun to give the world the result of valuable researches.

In a recent symposium on the subject of electricity the contributors mentioned his name with a sort of reverence, as one who has an almost magic power over the most hidden secrets of nature. Men in the foremost ranks of science, not only in the United States, but in Europe, believe that at no distant day he will announce discoveries which will be as far in advance of our present knowledge of electricity as the telegraph was over the mail coach. He has delivered only three or four lectures—one in Philadelphia, one in St. Louis, another in Paris and another in London—but each lecture has been listened to and applauded by the very *creme de la creme* of the scientific world.

MODESTY ONE OF HIS VIRTUES.

Another remarkable characteristic about Mr. Tesla—especially when we consider the self-assertive age in which we live—is his modesty. This serves to make him more highly esteemed by his associates and only adds to his renown. His friends might truly exclaim with the old dramatist, "Thy modesty is a flambeau to thy merit."

It is only affirming the truth when it is stated that many of the high compliments he receives annoy him. He honestly does not believe he is entitled to the praise that is continually showered upon him. He is an enthusiastic worker in his profession, but believes that he is only one of the standard bearers in the great march of human progress, and that he is as much indebted to other minds who have studied and worked in this new science as others think they are indebted to him. In his famous London lecture, after expressing how deeply he felt the honor of addressing the foremost thinkers of the day, his next sentence showed the character of the man. He said:

"The results which I have the honor to present before such a gathering I cannot call my own. There are among you not a few who can lay better claim than myself to any feature of merit which this work may contain. I need not mention many names, which are world known—names of those among you who are recognized as the leaders in this enchanting science; but one, at least, I must mention—a name which could not be omitted in a demonstration of this kind. It is a name associated with the most beautiful invention ever made. It is Crookes."

Crookes is a writer famous for his descriptions of experiments on radiant matter.

A REMARKABLE MOTHER.

Mr. Tesla, like many famous men, had a remarkable mother. She died only two years ago at the age of sixty. She was a simple woman, but in the surrounding territory in which she lived, both far and near, was considered the most remarkable female in the land. She inherited the inventive spirit from Mr. Tesla's grandfather, an inventor and constructor of machinery, who was an exceptionally ingenious man. Old Mrs. Tesla was an indefatigable worker. As a rule she arose at four o'clock in the morning and every day worked until late at night.

The home of the Teslas was in a very wild country, away from any of the conveniences of civilization, and Mrs. Tesla displayed her inventive faculty by constructing nearly all the appliances that were necessary for use in the household, and that, too, without ever having seen patterns from which to make them. For instance, in the matter of weaving, she would plant the hemp and flax, get out the fiber, spin thread and then construct the necessary mechanical appliances for weaving, making her own loom and producing for her large family all kinds of cloth from the heaviest, suitable for outdoor garments in the winter, down to the finest pieces, suitable for embroidery work. When she died, so great was she held in esteem that the whole country for miles around mourned her loss.

Mr. Tesla is such a hard worker that he has little time for social pleasures, if, indeed, he has any taste in that direction. He is a bachelor, tall, very spare of build, has dark, deep-set eyes, jet black hair and an expression that suggests at once the deep thinker. Though polite and even friendly to newspaper men, he has no desire to exploit himself in print. He has been the talk of the scientific world for five years, but the following interview I had with him a few days ago is the first that has ever appeared in any journal:

TESLA'S AUTOBIOGRAPHY.

My interview with Mr. Tesla commenced with a request that he give me a brief account of his life. He replied:

"I was born in a little place called Smiljan, on the border country of Austria-Hungary, this special section of territory being known as Lika. I am now thirty-six years of age. I have gone through the educational training that a young man usually receives in Europe, and nearly eighteen years of my life have been spent in schools. I completed my preparatory studies in Gospich and Carlstatt, and the Polytechnic School in Gratz, Austria. My first employment was engineering; then I was connected with the Hungarian Government Telegraph Company; afterward I engaged in telephonic work. After this I was interested in the electric light industry, and finally in the transmission of power.

"In 1884 I came to this country, my principal object being to develop certain ideas of inventions which I had vainly tried to develop in Europe. For a while I worked with Edison. In the beginning of 1885 a company was formed in my name. I developed for this company certain inventions, brought out a system of lighting and peculiar appliances belonging to that system. In the following year another company was formed—some time in 1886—the object of which was to introduce a motor of my invention. This motor is based on what is now the well known discovery of the rotating magnetic field, as it is technically called. The best way to give an idea of this discovery to one who is not technically educated in these matters is to put it as follows:

"A magnet, as it is well known, will attract a piece of wire and hold it. It was my good fortune to discover a method of constructing a magnet in such a way that it would not hold the iron, but spin it round and round."

I asked Mr. Tesla to kindly give me some further information in regard to his family.

TESLA'S FAMILY AND HOME.

"My father," he continued, "was a prominent clergyman attached to the Greek Oriental Church, an orator and a writer of note. He was a man highly educated, who spoke fluently a great many languages and also ranked high as a mathematician. He was an omnivorous reader, and possessed a large library, from which it was my privilege to gather a great deal of information during the years of my life spent at home. My uncle, his brother, was another skilled mathematician, and professor of a military academy in Austria. He wrote a number of standard works on mathematics.

"My mother died about two years ago. One of her brothers—the youngest—is one of the leading dignitaries in the Greek Oriental Church, having the rank of a cardinal. He is comparatively a young man and a famous orator.

"The section of country in which I was born was an exceedingly wild region—a mountainous and rocky region—with, however, many stretches of beautiful scenery, but poor from the agricultural point of view. In fact, they had a homely though somewhat sacrilegious saying in our land that when God distributed the rocks over the earth he carried them in a sack, and that when he was above our land the sack broke.

"I was interested in electricity almost from the beginning of my educational career. I read all that I could find on the subject. All the phenomena I witnessed in this line only excited my interest. When I was a mere boy I began to experiment with batteries

* From the New York *Herald*, April 23, 1893.

and induction coils, also with frictional and static machines. When I attended the Polytechnic School, at Gratz, I began to devote more and more of my time to electrical studies, and after I left the school I may say that, practically, all my time was taken up with the study of electricity.

EVIDENCES OF GENIUS.

"Originally, I closely followed up the course of mathematics and physics, with the view of graduating as a professor of those sciences. It was, I think, in 1875 or 1876 that we experimented in the Polytechnic School with one of the first practical dynamo machines, which was brought out by M. Gramme, a Frenchman. It occurred to me that a machine might be constructed without the complication of what is technically called commutator and brushes. A commutator is used on electric current generators and motors and on induction coils and elsewhere for changing the direction of currents. The brushes are pieces of copper or other material that bear against the cylindrical surface of the commutator.

"I remember that my professor at that time tried to demonstrate that such a machine was out of the question—in fact, an impossibility. I must confess to a feeling that I, in common with many better men, have had from early youth. As a youth, when I was told that a certain thing was impossible, it only served to arouse within me a spirit of contradiction. In this particular instance I began to think about and to work on a machine made according to the idea that had occurred to me. Day and night, year after year, I worked incessantly.

"After working several years I am happy to say that I was able to produce a motor which is now gradually being introduced in the United States. It is a machine of ideal simplicity, requiring no attention whatever. It should be remembered that in recent years there has been a wonderful advance along almost all electrical lines. What were at one time supposed to be novel or impossible schemes of doubtful accomplishment have proved to be feasible. Encouraged by this condition of affairs I have afterward devoted my energies to the production of a more practical illuminant than we have at present, and am still pursuing my labors in this direction.

DISCOVERIES ABOUT LIGHT.

"The most wonderful phenomenon in nature is light, and the most remarkable feature connected with man's physical life is the eye, which is the only organ capable of being affected directly by the vibrations of the ether. We could see for an immense distance if it were not for gases and particles that fill up the intervening space. These absorb the energies of the air.

"In pursuing this line of work I have had the good fortune to discover some facts which are certainly novel and which, I am glad to say, have been recognized by scientific men both here and abroad. I think the probable result of these investigations will be the production of a more efficient source of light, thus supplanting the wasteful processes of light production.

"My experiments have been almost entirely confined to alternating currents of high potential. An alternating current is a current changed periodically in direction, and the word potential expresses the force and energy with which these currents are made to pass. In this particular case the force is very great. The fact that a current vibrates back and forth rapidly in this way tends to set up or create waves in the ether, which is a hypothetical thing that was invented to explain the phenomena of light.

"These currents permeate all space—not only the atmosphere, but solids as well—and the waves extend out in concentric spheres indefinitely into space. I utilize these waves in some of my experiments to produce certain phenomena. It is not an electric current in the sense in which we are popularly accustomed to use that term.

TRANSMITTING ENERGY THROUGH AIR.

"These experiments may be further illustrated in this way: Suppose you throw a stone in the center of a pool of water. While there would be no transmission of water from the point where the stone landed to the shore, yet the waves would reach the shore and exert force on the shore. In a similar way I utilize the force which I obtain in the manner described.

"One result of my investigations, the possibility of which has been proved by experiment, is the transmission of energy through the air. I advanced that idea some time ago, and I am happy to say it is now receiving some attention from scientific men.

"The plan I have suggested is to disturb by powerful machinery the electricity of the earth, thus setting it in vibration. Proper appliances will be constructed to take up the energy transmitted by these vibrations, transforming them into a suitable form of power to be made available for the practical wants of life. Primarily, the agent that I propose to use consists of an old-fashioned electrical spark, such as they light from a Leyden jar. This is rapidly discharged back and forth an enormous number of times. Every time that the spark seems to pass it is in reality passing hundreds of thousands of times, and each time it passes it sets up these waves in the ether which extend out into space. In other words, the result of the experiment is to disturb the equilibrium of the ether.

"I am hopeful that in no distant time this method will be deemed worthy of a practical trial. It may be proper to say that among other things I have already demonstrated that we do not need to have two wires to convey an electric current, one wire being sufficient, and, in fact, in some cases, better than two wires.

PHENOMENA OF RESONANCE.

"In the experiments of transmitting power by means of wires the phenomenon of resonance is to be observed. If one tuning fork, for instance, is set into vibration another one of the same pitch, anywhere within reasonable distance, will respond. That is a familar phenomenon of sound termed resonance. Now, if I set up these etheric vibrations that I speak of to a certain pitch, and my wire is within reach of these vibrations (not necessarily metallically connected) it will respond provided its pitch corresponds with that of the etheric vibration.

"In that way I obtain energy in another conductor without any metallic connection whatever. Where a single conductor is connected with the source of vibratory energy, these waves surge back and forth in that conductor very much as water would in a tube when you reverse it back and forth.

"One of my most interesting experiments is with the incandescent lamp with a single wire to it. I place in the center of this a piece of very refractory substance of any kind and connect that with the source of vibratory energy, and, with this as a center, these etheric waves are sent out in concentric spheres and are reflected back from the inner surface of the glass globe upon this small piece of refractory substance. The impact of the molecules of rarefied air in this globe creates such intense heat in this refractory substance (which is the focus) as to bring it to a high state of incandescence. It is difficult to find a substance that will stand that heat, but I have found some substances that stand it fairly well.

"The transmission through the earth can be effected at any distance; in fact, it matters little whether the distance is small or great.

OF INCALCULABLE VALUE.

"Such a result, if achieved, would, of course, be of incalculable value to the world and greatly advance the progress of the human race. In this great country (of which I am proud to be a citizen) we have water powers which, in aggregate amount, are sufficient to supply all the needs—in fact, far more than the needs—of the whole human race. Take, for instance, Niagara. This famous waterfall is estimated variously all the way from five to six millions horse power. Now, four millions horse power, economically directed, would light every lamp, drive every railroad, propel every ship, heat every store and produce every article manufactured by machinery in the United States.

"It will not be long before we can transmit that power under quite practical conditions, by means of wires with the alternating system, over distances as great as a thousand miles. Engineers now object to the use of very high pressures which would be necessary in such transmissions of power. But I believe the time will come when we shall transmit that energy without any wire.

"Since I have experimentally proved that we can get back electric impulses over one single wire without any return, we may avail ourselves of the earth as a medium of transmission as one difficult obstacle to overcome. In fact, the only serious objection to this scheme is to find a means to concentrate the energy of vibrations spread over a great area on one spot.

"If this power is to be transmitted across the ocean it will, of course, involve the expenditure of an enormous quantity of energy. It has been suggested that I can produce a set of lenses made of asphaltum or gutta percha, or any other good so-called non-conductor of electricity, and can concentrate these rays, or waves, to a focus where their effect would be powerful.

"This plan, if at all practicable, could be applied as well across the Atlantic as it could at shorter distances on land.

METHODS OF PRODUCING LIGHT.

"The present methods of producing light are very wasteful. The electric light is a considerable advance over the gas burner, as far as efficiency is concerned; yet even the electric light, as at present produced, is very inefficient. Of the energy of coal we only get about one-third per cent. in light in an incandescent lamp; much more, however, in an arc lamp, because in that lamp we can reach much higher degrees of incandescence, and because we have the advantage of an economical combination of carbon and oxygen.

"It is true that in recent years some notable improvements have been made in gas burners, and that, from a theoretical point of view, it is possible that a far more efficient burner than the ones at present in use may be produced.

"Probably the most important problem electricians are considering is the production of electricity by an efficient process from coal or other cheap substance; at least most engineers have this subject in view. I think it is fully as important, and, in the end, perhaps even more important, to apply our skill in discovering how to transmit power from the waterfalls to any distance, for then we would be able to obtain energy, without consuming any material, and our coal fields and forests would remain untouched, whereas the production of electricity from some material will involve the rapid consumption of that material.

"One of the problems which is of great importance, and the solution of which we are very likely to witness in a few years, is the transmission of intelligence to any distance without connection. From present experimental evidence it can be quite safely concluded that an attempt to transmit intelligible sounds through the earth from here, for instance, to the European continent, without any cable, will succeed beyond a doubt. But it is a question whether such a method, which I have advocated for two years, would be available for all purposes, such, for instance, as the use to which the Commercial cable is put.

"In that case it is questionable whether the scheme would be practicable. But one thing is certain, we will be able to transmit universal time all over the earth, and also be able to send in the same way very important short messages from center to center.

"Electricity is becoming more and more an important factor in our daily life, and more and more closely connected with our comfort. I think, after a considerable lapse of time, it will become practically necessary for our existence. For instance, there is the question of light. The advantages of the electric light are so great that even with the present wasteful methods we have been able to succeed in making practical use of it.

"But what will be our success when we shall be able to produce a hundred times as much light as we do at the present day? To do this is merely a question of time. Electric power is obtained by the use of dangerous, cumbersome and complicated appliances. But we have electric machines now which require no attention whatever, and which will in a few years supplant all other motors, simply because of their higher efficiency and ideal simplicity.

"Even now the cost is very great. Eventually we will be very likely to be able to heat our stoves, warm the water and do our cooking by electricity, and, in fact, to perform any services of this kind required for our domestic needs.

"It has been said that it will be impracticable to heat our houses by means of electricity, on account of the great cost of coal; but, as I have said, we are now looking for other methods of getting electrical energy cheap. Even with the present methods any rich man certainly prefers, instead of a stove in his room, to have it warmed by electricity. The method is expensive, but ideal.

"Electric energy can be applied to bicycles, carriages and all sorts of vehicles. It will certainly be applied to rowboats, and will probably be so cheap that any man in ordinary circumstances can own a boat and propel it by this means. It would be a gloomy prospect, indeed, for the world if we did not think that this great power will be used to the advantage of the vast majority of the human race, and its benefits will not be confined merely to the wealthy.

INTERESTING EXPERIMENTS.

"I am working on some other lines than those of which I have spoken, and if I succeed in my experiments they will be of great interest, principally to scientific men. They have also a practical bearing upon what newspapers sometimes call the 'burning questions of the age.' These experiments are quite apart from old notions and the lines which heretofore have taken up my attention. I cannot tell how soon I will complete these experiments.

"Most of my experiments heretofore have involved either rapidly alternating currents of high potential or have reference to these electrical waves which are set up by alternating currents, and which, if very rapid, will not go through electric batteries at all, but will go through the best insulators. If they are less rapid, they will go through electrical conductors fairly well.

"I think I have received full praise for the work in which I have been engaged. There are some experiments which I made a few weeks ago in Philadelphia and St. Louis which interested our scientific men. For their benefit I have a technical account of these experiments in preparation, which will be published in the future in the scientific journals.

"Some years ago I demonstrated that a lampate filament could be made to glow from a current from a human hand. The light coming from the hand is produced by the agitation of the particles of molecules of the air. I charge my body with electricity, and from an apparatus which I have devised I can make the electricity vibrate at the rate of a million times a second. The molecules of the air are then violently agitated, so violently that they become luminous, and streams of light then came out from the hand.

"In the same manner I am able to take in the hand a bulb of glass filled with certain substances and make them spring into light; I make light come to an ordinary lamp in a similar way, simply by holding it in the hand.

"When I was in London I had the pleasure of performing one of these experiments privately before Lord Rayleigh. I shall never forget the eagerness and excitement with which that famous scientist saw the lamp light up. I can only say that the appreciation of such men amply repays me for the pains I take in working out such phenomena.

TESLA'S TRIBUTE TO AMERICA.

"When I arrived upon your hospitable shores, I eagerly applied myself to work and to learn, and I have persevered in that course. If I have made any special success in this country, I attribute it largely to a feature which is characteristic of both the English and American races; that is, their keen and generous appreciation of any work that they think is good.

"I think this country may well boast of its colleges. Take, for instance, Columbia College, Cornell University, Johns Hopkins University, or any of the institutions where nowadays electrical engineers are trained.

A GOOD PROFESSION.

"I consider electrical engineering a very good, profession for a young man, but it is a profession which requires considerable exercise of intellect. On account of the fascination connected with the study of electricity the profession draws to its ranks an intelligent class of young men.

"Of course, it is probably true that the majority of young men who enter the profession are more or less enthusiastic, but in these days a knowledge of electrical engineering has become almost indispensable for engineers in general.

"Nearly every engineer at the present time follows with great interest its developments. And it is the same with the medical profession, for physicians are realizing more and more that electricity will play a still larger part than it does in the cure of disease.

"For instance, a great amount of electrical energy may be sent into the body by means of high currents, because the energy is dissipated laterally from the body and is not passed through it in a direct manner, as it is when a current of low frequency is used. The feeling produced is somewhat different.

"I have also noted the importance of one being prepared for the shock. If you are prepared the effect on the nerves is not nearly as great as when you are not prepared. With these high alternations one feels but little pain in the central portion of the body. A remarkable feature of such high currents is that you feel a burn the moment your hand touches the wire, but beyond that the feeling is scarcely noticeable. I have received currents as high as 300,000 volts, an amount which, if received in any other way, would instantly kill."

TO MAKE CLOTH WATERPROOF.

CLOTHS intended for uniforms for policemen, railroad employes, and others, are rendered waterproof with acetate of alumina and isinglass or glue. The acetate of alumina is prepared by dissolving 5 kilogs. (11 lb.) alum and 5 kilogs. acetate of lead (sugar of lead), each in 10 liters (10 3-5 quarts) boiling water. Both solutions are poured while hot into a wooden dish, whereby a white precipitate of sulphate of lead takes place. The fluid is then left to cool, and the clear liquor, 5° or 6° B., is then decanted to be diluted according to need, say with 50 liters (52 4-5 quarts) water. On the other hand, 500 grammes (17⅝ oz.) isinglass or 2⅛ kilogs. (5 lb. 8¼ oz.) fine white glue are dissolved in water, after which the acetate of alumina is poured

into this solution. In this bath the ready finished cloth is left to steep overnight, and then permitted to drip off well. It is afterward dried, brushed and pressed. The bath is preserved, and used again after having been properly restored.

A one-graded acetate of alumina may also be rubbed in with brushes into the cloth, after which it is dried in the hot room, until the smell of acetic acid has disappeared. After this treatment, the saturation with a diluted glue solution (1:400) takes place.

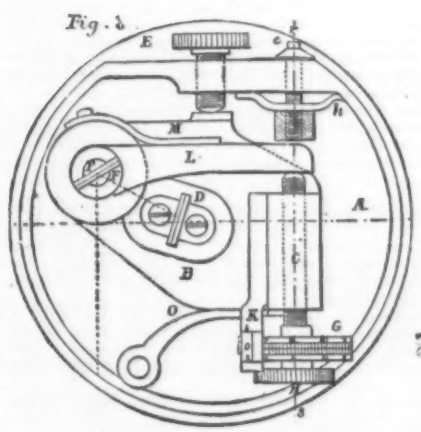
These porous waterproof cloths do not differ in their exterior from the ordinary kinds. If a swatch of such a cloth is moistened with water and examined with the microscope, it will be seen that all the fibers of the cloth have been changed into glittering cords of beads, intertwined by dark threads, and that numerous air bubbles are crowded upon the individual fibers —a condition that can be altered neither by sucking nor pressing, thus distinguishing the waterproof from the ordinary kinds of cloth.

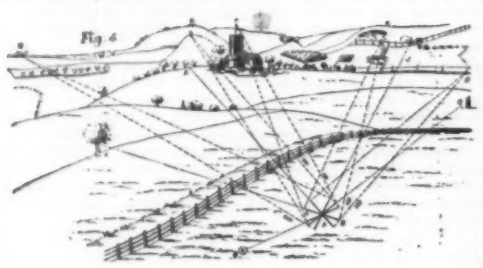
THE DREDGE-STEWARD OMNI-TELEMETER.

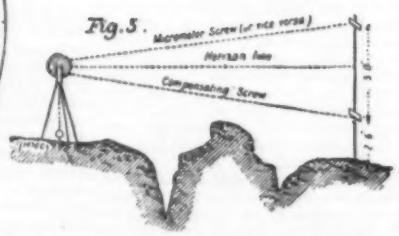
THE general view of the instrument is well shown in Figs. 1 and 2, below, while Fig. 3 shows a section through it. Our engraving and the description are from *Engineering*. From these it will be seen that the instrument is a modification of the ordinary box sextant, but in place of the two mirrors of the instrument being parallel to each other, when the graduation reads 0, the mirrors of the omni-telemeter make an angle of 45° with each other in this position, so that on looking through the instrument under these conditions the eye of the observer occupies the apex of a right angle, the sides of which are formed by the direct line of sight and that seen by reflection in the two mirrors. There is still another point in which the instrument differs from the box sextant. In that instrument, as is well known, one of the mirrors, viz., that known as the horizon glass, is fixed in position, while the fully silvered mirror only can be adjusted. In the Dredge-Steward instrument, however, both these mirrors are adjustable. Referring to Fig. 3, D is the mirror which is fixed in the sextant, but which, in the present instance, can be adjusted through a limited range by means of the micrometer screw, E. This mirror is mounted on an arm, B, which, turning round the pivot, F, at one end, is kept in contact with the screw, E, already mentioned by the spring, O, and it is by moving this arm that the mirror, O, is adjusted. At the free end of this arm is a nut, C, carrying a micrometer screw with a graduated head, G, as shown. The other end of this screw abuts against the arm, L, on which the fully silvered mirror, P, is mounted, and which can, therefore, be rotated through a small angle by turning the milled head H, of the micrometer screw. In using the instrument to take a range, as A, B (Fig. 6), the observer being at B, and facing so that the mark lies on its right hand, he views it by reflection in the instrument. The line of sight from the object reaching first the mirror, P, is reflected on to the mirror, D, Fig. 3, and from it to his eye. The observer now looking through the unsilvered part of the mirror tries to find some prominent object, C, which he can superimpose on the reflected image of A, without, be it understood, touching the micrometer screw, H. When this is done the angle, A B C, Fig. 6, is a right angle. Now putting a mark at B, he paces in the direction of C B, produced a distance B D = 50 yards, and looking again through the instrument as before, he turns the milled head, A, until the image of the mark, A, is again superimposed on C. Then reading the index on the micrometer screw, and referring to a short table attached to the instrument, he reads off instantly the range, A, B. Usually it is impossible to get a mark, C, such that the angle, A B C, is a right angle, without several trials, and it is here where the advantage of the omni-telemeter comes in, since it is not necessary with this instrument that the angle, A B C, shall be a right angle. Hence, if a point cannot be found fulfilling this condition, the observer chooses some point that nearly does so. Looking at this object and the mark through the instrument, when the latter is adjusted in its zero position the image of the mark will be to one side or the other of it. In this case the screw, E, is turned round, moving the mirror until coincidence is secured, and the second observation is taken at D, Fig. 6, as before. Owing to this adjusting screw, E, much less trouble is required to find a suitable mark on which to project the object whose range is sought. In the case of instruments having a fixed base angle, the observer may have to shift his position considerably before the desired coincidence is obtained. The adjustment allows base angles varying 8° on either side of 90° to be used, and it, therefore, is only in very exceptionally

FIG. 1.

FIG. 2.







THE DREDGE-STEWARD OMNI-TELEMETER.

monotonous countries that a suitable mark cannot be obtained with comparative ease.

The instrument has been tested by Mr John Coles, of the Royal Geographical Society, the author of "Hints to Travelers," for taking a round of distances from a central point which can be very quickly accomplished by the omni-telemeter. The best plan of doing this is indicated in Fig. 4. A stick is placed at the point, A, and distances of 25 yards measured on each side of it. Then to get any range such as E, a suitable object such as L is taken, and the observations taken at the points, B and C. To take the distance of the point, G, a man is sent out with a picket to O, and used as the auxiliary mark. For the range of the steeple, F, the mark, M, would be used, and J when taking H. In this way a whole round of objects can have their distances ascertained very rapidly. With moving objects two instruments are used, held by observers 50 yards apart, the line between them making an angle of nearly 90 deg. with the object. Both of the instruments having been first set to zero, each observer reflects the other on the object by using the micrometer screw, H. The range is then got by adding or subtracting the readings of the two instruments, the sum being taken when the zero line of the two is on the same side of the zero line of the scale, K, Fig. 3, and the difference when they are in opposite sides.

For telemetric surveying the following method of using the instrument has been worked out by Colonel A. T. Frazer, R.E., and is illustrated in Fig. 5. The instrument is mounted on its stand in the position shown in Fig. 2, and a bright object—Colonel Frazer uses a gilt prism—is placed on the ground vertically below it by means of a plumb bob. The instrument is then set to zero. An assistant is sent out to the object whose distance is required, with a staff having targets 5 ft. apart, the lower one being 2 ft. 6 in. from the ground. This target is aligned with the image of the ground mark by means of the compensating screw, E, and afterward the upper target is aligned by means of the index screw, the reading of which then gives, by reference to a table, the distance of the staff. This method can be employed in all cases when the slope does not exceed 8 deg., that being the limit of adjustment by the compensating screw. At the same time the instrument can also be used to ascertain the heights of objects the distance of which is known. For this purpose the instrument is mounted on its stand as already described, and the base of the object being reflected by the compensating screw on to the plumb bob, and then its summit by the other screw. The height of the object is then obtained from a table of rise in inches per yard. It is obvious that the instrument can also be conveniently used as an optical square, and hence, from what has gone before, it appears that it can be used almost as a universal instrument for preliminary survey work. For its original purpose, viz., that of a military range finder, we understand it is being supplied to the Indian government.

GREEN PIGMENTS.

Baryta Green.—Mix 2 parts caustic soda and 1 part chlorate of potash, and gradually add 2 parts very finely powdered manganese; heat gradually up to dull redness, then allow to cool, powder and exhaust with water; filter and cool, and add a solution of nitrate of baryta to the filtrate. A violet colored baryta precipitate forms; this is carefully washed, dried, and treated with ½ to 1 part of caustic baryta, hydrated and gradually heated up to redness, with constant stirring. The cool mass is powdered, and finally washed to remove any excess of baryta.

Brighton Green.—Separately dissolve 7 lb. sulphate copper and 3 lb. sugar of lead, each in 5 pints water; mix the solution, stir in 24 pounds whiting, and when the mass is dry grind to powder.

Brunswick Green.—(*a.*) Pour 3 parts saturated solution of sal ammoniac over 2 parts copper filings, held in a vessel capable of being closed, and keep the mixture in a warm place for some weeks, when the newly formed pigment is separated from the unoxidized copper by washing on a sieve; it is then washed with water and slowly dried in the shade. (*b.*) A solution of crude carbonate of ammonia is added to a mixed solution of alum and blue vitriol, as long as it affects it; in a short time the precipitate is collected, washed, and dried. (*c.*) Lighter shades are produced by the addition of sulphate of baryta, or alum.

Chrome or Guignet's Green.—Fuse together 3 parts of boracic acid and 1 part bichromate of potash at a dull red heat on the hearth of flame furnace. This forms a borate of chromium and potash, with evolution of oxygen. The mass is repeatedly washed with boiling water, which causes decomposition and consequent separation of hydrated oxide of chromium and a soluble borate of potash. The oxide is washed and ground very fine.

Emerald Green.—Form a paste with one part of verdigris in sufficient boiling water, pass it through a sieve to remove lumps, and gradually add it to a boiling solution of 1 part arsenious acid in 10 parts water, The mixture being constantly stirred until the precipitate becomes a heavy granular powder, when it is filtered through calico and dried.

Manganese Green.—Intimately mix 3 to 4 parts caustic baryta moistened with water, 2 parts nitrate of baryta, and 2 parts oxide of manganese; place in a crucible heated to dull redness, fuse, pour out, pulverize, digest in boiling water, wash in cold water, and dry in an atmosphere free from carbonic acid.

Mountain Green.—(*a.*). Native green carbonate or bicarbonate of copper is ground to powder, either with or without addition of a little orpiment or chrome yellow. (*b.*) Add a solution of carbonate of soda or potash to a hot mixed solution of alum and sulphate of copper.

Prussian Green.—A mixture of Prussian blue and gamboge.

Sap Green.—(*a.*) The juice of buckthorn berries is extracted by allowing them to ferment in wooden tubs for seven or eight days and pressing and straining. A little alum is added to the juice, which is evaporated down to a suitable consistency and run into bladders to dry and harden. (*b.*) Mix 11 ounces powdered arsenious acid, 1½ pounds carbonate of potash, and 1 gallon boiling water; dissolve, filter, and add to another solution of 2 pounds crystallized sulphate of copper in 3 gallons of water, producing 1½ pounds of pigment.

Scheele's Green.—Dissolve 1 part powdered white arsenic and 2 parts commercial potash in 35 parts boiling water; filter, and add the solution gradually while still warm to a filtered solution of 2 parts sulphate of copper as long as a precipitate falls; wash with warm water and dry.—*Chem. Tr. Jour.*

BLEACHING WOOL WITH SULPHUR.

THE bleaching of wool with sulphur is a comparatively simple process. It is generally performed in a sulphuring chamber, built of brick, twelve feet high, twelve feet broad and about seventeen feet long. This chamber is provided with tightly closing windows at the sides and at the ends with well closing doors. Usually in each of the four corners of the chamber is a stove for burning the sulphur. Two of these stoves have flues to conduct the sulphur vapors into the upper part of the chamber. Another arrangement is now much used, in which, at a sufficient distance above the floor, a false or perforated floor is introduced, and in the space between the two the sulphur is burned. When yarn is to be bleached, the moist skeins are suspended from rods in the chamber. In bleaching pieces of goods the moistened fabric, with the ends fastened together, is run continuously through the chamber.

When all the preliminary arrangements for bleaching have been completed, the doors are closed and the stoves set in operation. A certain quantity of sulphur is strewn upon each stove, and sulphur dioxide gas—sulphurous acid—is generated by its burning. This

acid operates upon the wool and bleaches it. By this method it is of great importance that the gas should circulate throughout the entire chamber, so that every part of the yarn or stuff is equally exposed to the bleaching influence of the vapor. This is best accomplished by permitting the vapors to enter the bleaching chamber at several places, and a fan is ordinarily used to force them toward the ceiling of the chamber. The quantity of the sulphur employed depends upon the quantity of the material to be treated. The amount necessary is about six or seven per cent. of the weight of the material to be treated. In order to have the whole quantity consumed, a certain quantity of air is necessary in the sulphuring chamber. To insure a complete combustion and conversion of the sulphur into sulphurous acid, an equal quantity of oxygen is required, of which the air contains about one-fifth part by weight. When, therefore, eight pounds of sulphur are to be burned, it requires forty pounds air; and, since one pound fills a space of a little more than 13¾ cubic feet, forty pounds air would occupy over 500 cubic feet of space. This is, theoretically, the amount of space required by a sulphuring chamber in which eight pounds sulphur are to be consumed. In practice, however, it requires nearly double this space, or from 800 to 900 cubic feet. The size of the chamber must, therefore, be correspondingly great. After having been sulphured, the goods are simply washed in water.

The sulphur bleach is not a completely effective process. The dyestuff is not actually destroyed, but it only enters into a chemical combination with the sulphurous acid, and forms with it a colorless body. When the wool is treated with some substance that neutralizes this combination, the former color returns again in its original strength. This effect is, for instance, produced by washing in feeble alkalies, or with soap and water. Another objection to the sulphur bleach is that by the burning of the sulphur a part of it volatilizes in a free form, and in this condition is deposited upon the wool and turns it yellow. This yellow color cannot be neutralized.

The goods must, after bleaching, be washed very thoroughly in order to remove every trace of sulphuric acid, which the wool often absorbs. If this should remain in the wool it would eventually destroy the fiber. In many places the wool is washed in a weak ammonia or soda solution. This is not advisable, however, since, by reason of the neutralization of the sulphurous acid by the alkali, the original color of the wool often reappears.

The sulphur dioxide may also be used in form of a solution in water instead of a gas. The goods are then simply immersed for a few hours in the solution of dioxide until they are bleached, after which they are rinsed well in water and dried. When employing this method, it is important to prepare the bleach liquor fresh immediately before use. If this is not done, the solution, after a time, will contain very little sulphurous acid, but much sulphuric acid, which has no bleaching properties, and is only injurious to the wool. —*Industrial Record.*

THE GOLDEN ROSE OF VIRTUE.

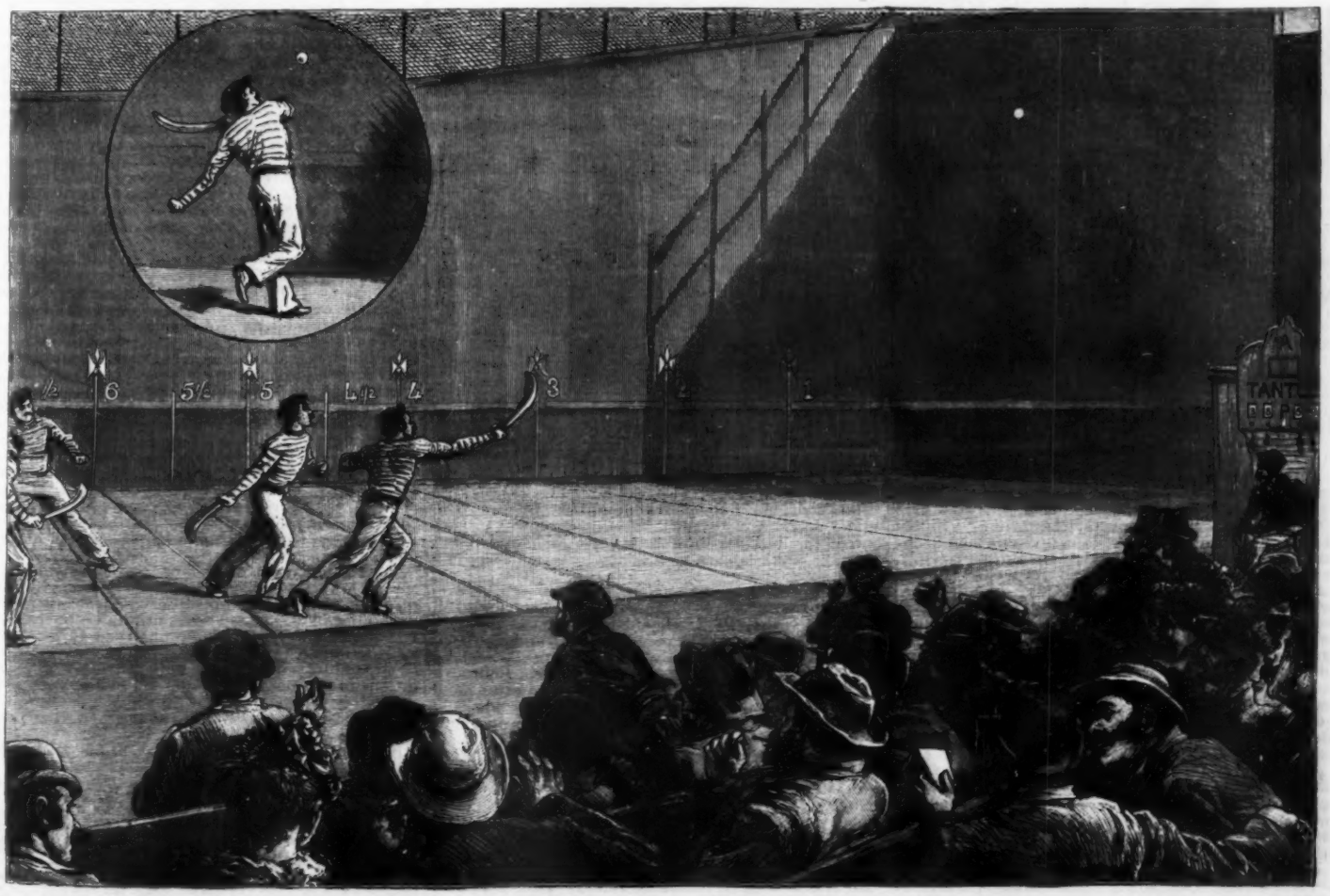
THE Golden Rose, which is presented by the Pope to eminent Roman Catholic princesses, will, it is said, be given this year to the Duchess Albrecht of Wurtemberg, who was married to Duke Albrecht in February last. Her Imperial Highness is the daughter of the Archduke Carl Ludwig of Austria, and was, before her marriage, Abbess of the Convent of Noble Ladies at Prague. She is known as a most devout Catholic. We are indebted, says the *Graphic*, to Herr L. Kohn for the photograph from which we take our illustration of the Golden Rose—that which was presented last year to Madam Carnot as wife of the President of the French Republic.

THE GOLDEN ROSE OF VIRTUE.

THE GAME OF "PELOTA."

WE have so good a conceit of ourselves and our games in England, says the *Graphic*, that it is rather difficult to persuade the average Englishman that other countries have their games of manual skill also, and that in some instances they are more interesting and have been brought to a higher state of perfection than anything we possess at home. We know, for instance, that the French play a *jeu de paume* not unlike our "fives;" but schoolboys would be slow to believe that to compare "pelota," as it is called in the land of its birth, with the bat fives would be like comparing cricket with skittles, let us say.

Pelota has its origin in the Basque provinces of Spain and France. It is extensively played on both sides of the Pyrenees, but to see it played to perfection one should visit the South American republics of Uruguay and the River Plate, for it is thither that most of the best professionals emigrate, finding a fuller appreciation of their talents in the New World and better pay. Buenos Ayres contains at least four or five great courts in which the game can be played, and some idea of the popularity of the entertainment may be gained from the fact that these courts are capable of seating over a thousand spectators, and, on the day of any great match, are crammed to suffocation. The court itself is sixty yards long by fifteen broad. It has one side wall and an end wall at right angles to each other. Facing these walls sit the spectators, tier upon tier; and seated upon their chairs on the space between the actual court and the front row are the umpires. The rules of the game are almost identical with those of bat fives. The number of points, or *tantos*, in a game are forty, though sometimes twenty-five or thirty only are played; and a board in full view keeps the interested spectator well acquainted with the varying fortunes of either side. The four players, clothed in white trousers, red or blue jerseys, and basque caps, wear on their feet, in place of our tennis shoes, the *alpargata*, a canvas slipper soled with straw. Upon their right hand is fixed the *cesta*, or *chistera*, with which they drive the ball. This instrument can best be described as resembling those wickerwork grooves which we sometimes put over the wheels of pony traps to save a lady's skirts from being muddied. It is rather more than a foot long, and the hand fits into a kind of glove at one extremity, being further bound round the wrist with leather thongs. With this they either strike or scoop the ball. As a matter of fact, the ball is caught, poised, and then driven back; but the three separate actions look like one, and the force with which the ball can be driven is infinitely greater than that which can be got out of a tennis racket. There are plenty of players who, standing in the middle of the court, can volley or half volley a ball against the end wall with such strength as to send it out of the other end of the court altogether: and it must be remembered that the court is sixty yards long. As in rackets or in tennis, a great deal depends on the service, and the man who is "in" has always a slight advantage; but the rallies, when once fairly started, are interminable. The agility, the extraordinary swiftness and subtlety with which a player will recover a difficult ball—especially in the back-handed strokes—and their marvelous judgment of distance, are almost inconceivable. Neither the tennis court of Prince's nor the racket court of Lord's have



"The game is played by four players, two on each side, each player having fixed on to his hand a basket-work hollow-scooped bat, called a *cesta*, with which he, in his turn, hits the ball. The game is made up of forty points, each miss counting one point to the opposite side."

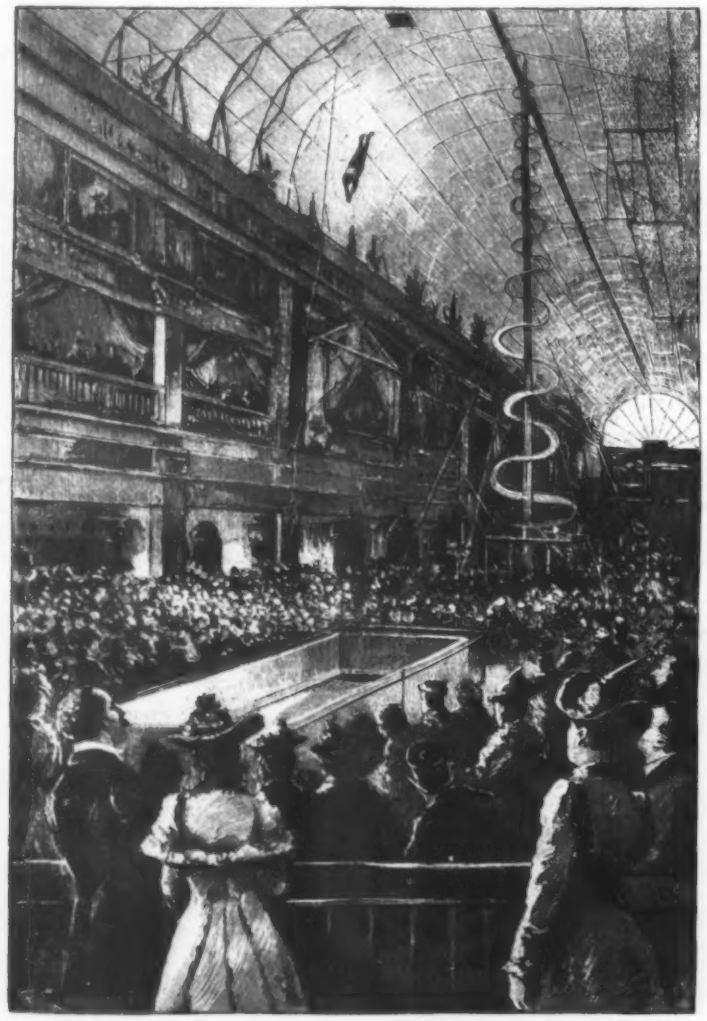
THE GAME OF "PELOTA"

ever seen such quick returns of balls which it seems absolutely impossible to "get up." Moreover, the players' powers of endurance are taxed to the utmost by the enormous size of the court and the space they have sometimes to cover. These latter are generally known to the public by their nicknames—*El Manco*, the one-armed; *El Chiquito*, the little one, and many other sobriquets, and in the intervals of play are the subjects of much tender solicitude and encouragement. For the spectators are often wound up to such a pitch of enthusiasm by a long rally and a good stroke that at the end of the round they will shower pieces of money and even their hats and walking sticks upon the player who has been fortunate enough to please them.

Unfortunately, the players do not always please them, and the cry of *lindo!*—"pretty stroke"—is not the only one that resounds through the court. The betting is very heavy indeed, and there are always the same suspicions connected with the game as are attached to horse racing. It takes very little to persuade a hot-headed South American, who has got a good deal of money on, that his side are losing the game on purpose; and then the hoarse shouts of *robo!*—"robbery"—entirely drown the applause of the triumphant backers. Indeed, it is to be feared that by far the largest part of the audience is assembled simply and solely for the sake of gambling. Our illustration is from a sketch by Mr. A. R. Airey.

BURNS THE DIVER.

To dive from a small platform suspended at a height of 83 feet into a tank of water 18 feet long, 9 feet wide and 7 feet deep, is a performance sufficiently thrilling to satisfy the most exacting audience. That is the sensation which "Tommy Burns" has provided for the patrons of the Westminster Aquarium. Since Baldwin made his parachute descent there has been nothing to equal this feat, and when Burns, having been hauled up to the platform, crouched down preparatory to taking his header, there was deathly silence throughout the great crowd of spectators. He comes down in a curve, with his legs over his back, and strikes the water with his shoulders, and the rest of his body comes down almost flat on the surface directly his shoulders touch, as if he had fallen on his back. The near spectators got a splashing, and the whole audience sighed with relief when the excitement was over, and the diver came puffing to the surface.—*Black and White.*



TOMMY BURNS' DIVE OF 83 FEET AT THE ROYAL AQUARIUM.

AUSTRALIAN EXHIBITS AT CHICAGO.

NEW South Wales is the only one of the Australian colonies that will be represented at the World's Fair at Chicago. All the courts of the colony are further advanced in the installation of the exhibition than any other nation. The art exhibits of New South Wales will occupy 6,000 square ft. of floor space and 10,000 square ft. of wall space. The arts court will be a most attractive feature of the display the colony is making. There will be a collection of over 600 large photos of the public buildings and works of the colony, street views, and country scenery. There will also be exhibits from the technological museum, the technical museum, and the technical college, and from the public schools of the colony. The work of installing the exhibits in the mining court is almost complete, and when finished New South Wales will rank first among the mining nations that will be represented. One of the main features of the display will be an ornamental column 38 ft. high, representing only a seventh of the silver product of the famous Broken Hill mine. All the ethnological exhibits of the colony have arrived.

FAMOUS GOLD NUGGETS.

IN order to correct many misstatements that are going the rounds of the press in regard to the largest nuggets of gold ever found, the editor of the *Silver Dollar* publishes the following facts, which he obtained while commissioner to the great Mining Exposition held in Denver, Col., in 1882, from the gentleman having charge of the Australian exhibit, which included models of all the large nuggets discovered in that great gold field.

The largest piece of gold in the world was taken from Byer & Haltman's gold mining claim, Hill End, New South Wales, May 10, 1872. Its weight was 640 pounds; height, 4 ft. 9 in.; worth $148,000. It was found embedded in a thick wall of blue slate, at a depth of 250 ft. from the surface. The owners of the mine were living on charity when they found it.

Welcome Stranger nugget was found on Mt. Mollegel, February 9, 1869, weighing 190 pounds, and was worth $45,000. This nugget was raffled for $46,000 at $5 a chance, and was won by a man driving a baker's cart. It was sold to the bank for its true value and melted.

The Welcome nugget was found at Bakery Hill, June 9, 1858. It weighed 184 pounds 9 ounces 16 pennyweights, and was worth $44,356; was raffled for $50,000 at $5 a chance and was won by a small boy in a barber shop.

Lady Hotham nugget—named in honor of the wife of the governor of New South Wales—was found in Canadian Gully, September 8, 1854. It weighed 98 pounds 10 ounces and 12 pennyweights, and was sold for $23,557.

Uncle Jack nugget, found at Buningorg, February 28, 1857, weighed 23 pounds and 5 ounces, and was sold for $5,620. It was found by a runaway sailor, who sold it for the sum named, and spent the money in just four weeks.

No Name nugget, found at Eureka, Daulton's Flat, February 7, 1874, 50 ft. below the surface, weighed 52 pounds 1 ounce, and was sold for $12,500.

The Leg of Mutton nugget was found at Ballarat January 31, 1853, at a depth of 65 ft. It weighed 134 pounds 11 ounces, and was sold to the bank for $32,380. This nugget was shaped like a leg of mutton, hence its name.

No Name nugget, found at Bakery Hill, Ballarat, March 5, 1855, near the surface, weighed 47 pounds 7 ounces, and was sold for $11,420.

No Name nugget, found at Canadian Gully, Ballarat, Jan 22, 1853, at a depth of 25 ft., weighed 84 pounds 3 ounces 15 pennyweights, and was sold for $20,235.

The Kohinoor nugget, found at Ballarat July 27, 1869, at a depth of 160 ft. from the surface, weighed 69 pounds, and was sold for $16,680.

Sir Dominic Daly nugget, found February 27, 1862, weighed 26 pounds, and sold for $6,240.

No Name nugget, found at Ballarat February 28, 1850, only 16 ft. below the surface. The discovery was made by a small boy. The nugget weighed 30 pounds and 2 pennyweights, and sold for $7,365.

No Name nugget, found at Webville, August 1, 1869, weighed 12 pounds, and was worth $2,280.

No Name nugget, found at Ballarat February 3, 1853, just 12 ft. below the surface, weighed 30 pounds, and sold for $7,360.

No Name nugget, found in Canadian Gully January 20, 1853, at 18 ft. below the surface, weighed 93 pounds 1 ounce 11 pennyweights, and sold for $22,350.

No Name nugget, found at Bakery Hill March 5, 1858, weighed 40 pounds, and was worth $9,600.

Nil Desperandum nugget, found at Black Hills November 29, 1859, weighed 45 pounds, and sold for $10,800.

Oates & Delson nugget, found at Donnelly gold field in 1880, at the roots of a tree, weighed 189 pounds, and sold for $50,000.

In addition to the above were the Heron nugget, worth $20,000, and the Empress nugget, worth $27,661.

Gold in the drift deposits has been found in larger masses in Australia than in any other country. Many large nuggets were found in California during the era of placer mining, but we have no record of any to compare with those we have described in Australia.

SEAWEEDS.*

By E. M. HOLMES, F.L.S., Curator of the Museum of the Pharmaceutical Society of Great Britain.

I.—SEAWEEDS APPLIED IN MEDICINE.

IT would not be possible in the brief time at our disposal, either to enter into details concerning the classification of seaweeds, or to describe the advances that have been made in the knowledge of this class of cryptogamic plants.

I propose, therefore, to offer a few remarks upon some of the species which have been, or still are, of more or less direct interest to the pharmacist, and to indicate to those who are lovers of nature and of science a few points concerning seaweeds which are still awaiting investigation.

The first fact to which I desire to direct your attention is that every good species of seaweed must be regarded as distinct, not merely in form and structure, but in its vital processes and the chemical products it elaborates.

This individuality is the more remarkable because seaweeds live under less varied conditions than ordinary plants. Although some of the larger algæ, such as the oarweeds (Laminariæ) and honey ware† (alaria), etc., appear to be furnished with roots, yet it is well known that these are mere hold-fasts, and do not obtain nourishment for the plant. It, therefore, has to absorb nourishment through its entire external surface from the medium in which it grows. Although sea water varies, so far as we know, only in its temperature and its degree of salinity, yet different species growing in the same locality not only exhibit peculiarities of growth and structure, but also yield different products.

One of the marine algæ best known to pharmacists is, perhaps,

Fucus Vesiculosus.—For the sake of comparison it may be pointed out that there are six common and two rare species of fuci (excluding varieties) occurring in Britain that are usually referred to this genus.‡ These are F. canaliculatus, F. ceranoides, F. platycarpus, F. vesiculosus, F. nodosus and F. serratus. The two rare species are F. anceps (Ireland) and F. distichus (Scotland). Only two of these possess air bladders, viz., F. vesiculosus and F. nodosus. In the former the frond has a midrib, and the bladders are situated usually on each side of it. In the latter the frond is compressed but thicker, and has the air vesicles immersed in its substance; the receptacles or organs of fructification are borne on short lateral peduncles. These species occupy different situations on the shore. F. ceranoides is found in the brackish water of estuaries and marine lochs. F. canaliculatus grows on rocks near nigh water mark, and is exposed to the air during a considerable part of the day; it is a small plant, with channeled fronds. F. platycarpus occurs near high tide level, and the others follow in succession toward low water mark in the order in which they are mentioned. In some places, as at Smallmouth, near Weymouth, these plants can be seen forming distinct zones of growth. The species vary much in size and in width of the frond according to the conditions under which they live. Thus, Fucus vesiculosus has a very broad frond when growing in still water in bays, and a narrow one when hanging over a rock and exposed to the pouring of the waves over it, the pressure thus exerted probably tending to elongate the cells, just as happens with batrachian Ranunculi in rapidly flowing fresh water.

The lifting power of a large plant of the bladdery species is very considerable. Some years ago a naturalist was much puzzled by observing tracks in the sand, which began and ended without any visible cause. On watching for some hours he observed that stones of considerable size were floated by the fuci growing on them, and on being carried shoreward left the indentations in the sand.

Possibly these bladders serve some purpose in enabling the plant to retain the position that suits it best.

Some idea of the vast quantities of fuci that grow on

* A paper read recently before the Chemists' Assistants' Association, London.

† The word ware is probably identical with "wrack," the name applied to fuci. The equivalent French word, vareck or varec, vraic in Jersey, or wrack in England and Scotland, has a double meaning, it being applied to goods or merchandise (as in the English words hardware, tinware, warehouse), and also to goods thrown up by the sea on shore; and in this sense the words vareck and wrack are evidently applied to seaweeds. We see also the connection with the words wreckers and wreck, and with wrack as used in the well known quotation, "Left not a wrack behind." The term honeyware seems to be a modification of honey, *i. e.*, sweet ware.

‡ F. canaliculatus is now usually referred to a distinct genus, Pelvetia, in which there are only two oospores in the onium. F. nodosus is in like manner placed in the genus Ascoplaylum characterized, having four oospores in the organism. In fucus there are eight.

our shores may be gathered from Mr. Stanford's statement that he has seen as much as 10,000 tons cut in a single loch during the summer for making kelp. One hundred tons of wet seaweed yield 5 tons of kelp or 2½ tons of soluble salts. One loch would, therefore, yield in one summer no less than 250 tons of salts.

The work that is effected by seaweeds in abstracting mineral matter from sea water is thus seen to be enormous.

It might be supposed that the mineral constituents of marine algæ are due solely to the amount of sea water contained in their cells, but this is not the case, since the character and amount of the salts present vary in diffent species.

It has also been suggested that the greater or less degree of immersion in water during the ebb and flow of the tide, due to the position in which the plant grows, affects the amount of certain salts present. Thus, in the true fuci, the amount of iodine present is less in those exposed to the air for the longest period, as seen in the following table, given by Mr. E. C. C. Stanford:

	Iodine per ton in lb.	
Fucus vesiculosus	0·665	bladder wrack
Fucus nodosus	1·282	knobbed wrack
Fucus serratus	1·887	black wrack

But a comparison with other algæ growing in sea water and exposed only at extreme low tides will show that this is not the rule.

	Lb. of iodine per ton.
Himanthalia lorea	1·998
Chonda Filum	2·688
Halidrys siliguosa	4·773
Chordaria flagelliformis	6·298

It may be noted also that the official species of fucus is not the richest in iodine.

Laminaria.—The British species usually referred to this genus are five in number, viz.: L. hyperborea, Fosl. (L. digitata, Lyngb.), L. digitata, Edm. (L. stenophylla, J. Ag.), L. saccharina, Lamx., L. hieroglyphica (J. Ag.), Sacchorhiza bulbosa, De la Pyl. (L. bulbosa, Lamx.)

These are techically known to kelp makers as "tangle," in contradistinction to the fuci, which are denominated "wrack." The first two species are those chiefly used in the preparation of kelp, being particularly rich in iodine, the third has been suggested for use in emulsifying cod liver oil, the fourth and fifth are interesting chiefly from a botanical point of view.

The first, L. hyperborea, grows below tide mark, being rarely exposed even at the lowest spring tides, but it is often thrown up in immense quantities after storms. It has a rough or watery stem, which stands erect in the water. The second is usually exposed at low tides and has a smooth flexible stem, and is, therefore, more or less decumbent. Both of these species have the lamina or blade split up into ribbon-like pieces. In the third species, L. saccharina, the blade is ligulate and wavy at the margins, and has large transverse wrinkles. L. hieroglyphica differs from L. saccharina, chiefly in the wrinkles being in a longitudinal direction and much more numerous. L. bulbosa is quite distinct from all the above, and is now placed in a separate genus, Sacchorhiza, on account of possessing cryptostomata, *i. e.*, small cavities in the frond, from each of which a tuft of hairs arise.

The mode of development of these plants is extremely curious, and affords an excellent example of intercalary growth. At this time of the year the fronds of Laminaria saccharina will be found to have a thin and paler portion developed between the top of the stem and the old lamina, with a constriction between the two parts of the lamina. The paler portion is the new frond which is developed between the stem and the old lamina. After a time the constriction increases and the old frond drops off. This is evidently a provision of nature for distributing the species, since the old frond bears the fructification, which is thus floated to other localities.

If the old frond be held up to the light, the fructification is readily seen. Under the microscope it is found to consist of linear, elliptical, unilocular sporangia, nearly hidden at the base of densely packed paraphyses. It may here be of interest to point out that although the Laminariæ are extremely common in temperate latitudes, the plurilocular sporangia are absolutely unknown. Yet there is little doubt that all that is needed to discover them is continuous and discriminating observation, for an acute observer, Mr. T. H. Buffham, has recently detected the plurilocular sporangia of the equally common Chorda Filum (or sea laces), which until last year were also unknown. These are found on the same plant as the unilocular sporangia), but on the upper portion of individuals which have become enlarged and spirally formed toward the apex. It is a remarkable fact that although the plants of this family exceed all other algæ in size,* yet their reproductive organs are of a low type, consisting only of zoospores.

It may also be mentioned that the zoospores of the subclass Phœophyceæ, or brown algæ, to which the Laminariaceæ belong, differ from those of the Chlorophyceæ, or green algæ, in the cilia being of different length, in being attached at the side, and in the longer cilium being carried forward when the zoospore is in motion. In the green algæ the cilia are both attached at the narrow end, and are usually of equal length. In both cases the zoospores are ovate, the narrower end being in front when in motion. These zoospores are best observed early in the morning, when they are generally set free. If green algæ in fruit be placed in a glass vessel containing sea water, the microzoospores move to the side facing the light, and the macro-zoospores to the side away from it. The former germinate after conjugation, the latter without conjugation. Consequently, the former may be regarded as a sexual and the latter as an asexual mode of propagation analogous to that of gemmæ or bulbils in higher plants, or to the tetraspores of the Rhodophyceæ. The reverse is supposed to be the case with the Phœophyceæ, in which the smaller or micro-zoospores found in the unilocular sporangia are supposed to be asexual, and the larger macro-zoospores contained in the plurilocular sporangia are believed to be sexual, and these sporangias are hence distinguished as gametes.

Returning to the other species of Laminaria, it may be remarked that the young frond of L. hyperborea is developed in a similar manner, but when nearly full grown, longitudinal fissures appear here and there in the new frond and extend gradually to its apex; the old frond then decays at the constriction, and is easily torn off by the force of the waves.

In Saccorhiza the development of the plant is still more curious. The young plant might be easily mistaken for that of L. hyperborea, or of L. saccharina, but for a very inconspicuous ring near the middle of the stem. This ring gradually enlarges, and ultimately bends downward until it reaches the rock, the lower part of the stem meanwhile having its growth partially arrested. When the ring touches the rock it attaches itself by numerous warty projections, assumes a hemispherical form, and forms, ultimately, a large, stout globular body, often a foot or more in diameter, and studded all over with warty projections, which serve to attach it to surrounding objects. The lower half of the original stem then gradually disappears. This species grows where the shock of the waves is greatest, hence the use of its strong base. Before leaving the natural history of the Laminariæ, it may be interesting to observe these plants, like many other algæ, have their own peculiar epiphytic species. Thus, Ectocarpus Hinchsiæ may be found almost to a certainty on the fronds of Saccorhiza bulbosa, but I have never met with it on any other host plant. In the same way, Ptilothamnion pluma may be found on the warty stems of L. digitata, and rarely, if ever, elsewhere. The warty stems of this species of Laminaria are a fertile hunting ground for rare and deep water species, and when thrown up after a storm, especially on our northern coasts, have repeatedly been found to yield epiphytic species otherwise obtainable only by dredging, *e. g.*, Euthora cristata, Petrocelis Hennedyi and Delesseria angustissima. From a chemical point of view the species of Laminaria are also extremely interesting. The proportion of iodine varies considerably in different species: this will be seen from the following table given by Mr. Stanford:

LAMINARIA DIGITATA, EDM.

	Lb. of iodine per ton.
Frond	10·702
Stem	9·021

L. HYPERBOREA, FOSL.

Frond	6·599
Stem	10·158
Saccharina, Lanox	6·258
Saccorhiza bulbosa, De la Pyl.	4·403

L. digitata is frequently exposed at low tides for two hours or more, but L. hyperborea is barely left uncovered by the tide, yet it will be observed that the L. digitata contains the most iodine, which is exactly the reverse of the percentage in the fuci.

When we compare the quantity of iodine present in these plants with the amount present in sea water, we find an extraordinary difference. Sea water is stated to contain only 1 part of iodine in 291,000,000 parts, but L. digitata contains 1 in 250. It has, therefore, an extraordinary power of absorbing and retaining iodine in its living tissues. As its stem is perennial, its richness in iodine might be supposed to be due to a gradual accumulation, but as the annual deciduous frond of L. digitata contains nearly as much as the stem, this supposition will not account for it, nor for the fact that Chondrus crispus and many other species contain the merest trace of iodine, or none at all. We are here, therefore, face to face with the problems, by what means is this element abstracted from the sea water and of what use is it to the plant?

In most Laminariæ the fronds are observed when collected on the shore to be remarkably mucilaginous, and if a frond in the dried state is observed with a lens, a network of veins can be observed. This network consists of a number of anastomozing tubes, which commence at first as intercellular cavities formed between cells under the epidermal layer. The contiguous cells develop into glands and the cavities gradually communicate in a horizontal direction with each other. From this network of gland-containing tubes vertical canals are formed between the cells, which do not however pierce the epidermis. The free mucilage in which these plants abound is secreted by these glands, and when the epidermis is injured it escapes. The formation of these muciparous glands and anastomozing canals has been carefully studied recently by M. L. Guignard (*Ann. Sch. Nat.* (7) t., xv., pp. 1–46), who watched their development by following the growth of the new frond from its first appearance at the top of the stem.

The chemical nature of the mucilage was ascertained a few years ago by Mr. E. C. C. Stanford, of the North British Chemical Works.* He found it to consist of salts of a new organic acid, which he named alginic, with magnesium and sodium. The mucilage when evaporated to dryness becomes insoluble in water, but is readily soluble in solutions of alkalies or alkaline salts.

A large quantity of alginic acid is present in Laminaria. From the dried plants cold water removes about 33 per cent. of soluble matter, of which about 20 per cent. consists of mineral salts and the remainder of dextrin, extractive and mannite† (7·47 per cent.), leaving 66 per cent. of matter insoluble in water. This appears to consist largely of alginic acid, since when the fresh frond is treated with carbonate of sodium a thick solution of the alginate is obtained, which, however, requires straining. It is so extremely viscous that a two per cent. solution is quite thick and a five per cent. solution cannot be poured out of the vessel containing it.

This new acid differs from albuminous bodies in not coagulating when heated; from gelose in not gelatinizing when a hot solution is cooled; from gelatin in not being precipitated by tannin; and from starch mucilage in not being colored by iodine. It forms precipitates with the alkaline earths, except magnesia, and, like gelatin, becomes insoluble when treated with bichromate of potassium and exposed to the light. When dissolved in ammonia or borax it can be combined with a similar solution of shellac.

From the crude solution obtained as above described alginic acid can be precipitated by sulphuric acid in the form of flocks, which, by the addition of a bleaching agent and subsequent washing and subjection to hydraulic pressure, can be obtained in the form of a white, hard substance, which will take a good polish.

The mucilage of Laminaria has also been suggested by Mr. J. Wheeler, of Ilfracombe, as a vehicle for emulsifying cod liver oil, which is thus administered together with iodine and bromine in an elegant form. For this purpose he prefers Laminaria saccharina. He has published a formula for an infusion and tincture of Laminaria digitata, Edm. (L. flexicaulis, Le Jol.), and for an emulsion of cod liver oil made with a decoction of Laminaria saccharina. The use of the dried and powdered L. digitata was also recommended as a resolvent poultice (*Pharm. Journ.* [3], xii., p. 642).

II.—SEAWEEDS USED AS FOOD.

The species of marine algæ employed as food in this country are few in number. Porphyra laciniata is collected and sold in Devonshire under the name of "laver," and was obtainable even in London a few years ago. In Edinburgh and Glasgow, Rhodymenia palmata is still sold under the name of "Dulse," and the midrib of Alaria esculenta is eaten in Ireland under the name of "Murlins." Laver is generally served up hot like a vegetable with meat. Dulse is sometimes boiled in milk, but is often eaten raw, and is considered tonic and stomachic.

In China and Japan enormous quantities of marine algæ are utilized as food in soups and made dishes. In fact, seaweed is one of the regular articles of trade mentioned in the Chinese Yellow Books. Many of them are sold cut up in shreds like tobacco, and are not easily recognizable. Those that I have seen in a sufficiently entire state for determination consisted of Porphyra laccinata, Laminaria Japonica, Glocopeltis tenax and Ulva lactuca; but there are numerous other kinds used which have not yet been identified.

Porphyra laciniata is regularly cultivated in Japan. For this purpose plantations of branches of coppiced oak (Quercus serrata, Thunb.), made into fagots, are inserted at low water into the mud or gravelly shore, in which holes are made by a special instrument. After some weeks a crop is collected from these fagots, which are of course immersed to a considerable depth at each high tide. After being picked over, washed and placed on bamboo frames to dry, the seaweed is compressed and packed in neat bundles. The whole process may be seen illustrated in the Japanese book I have placed upon the table; which also contains representations of other edible Japanese algæ as yet not identified. Some of the marine algæ used in different parts of the world as food are remarkable for the large quantity of gelatinous matter that they contain. Of these may be mentioned Eucheuma speciosum, Eucheuma spinosum, Gelidium spinosum, Chondrus crispus and Gracilaria lichenoides. In these algæ we find that each has its individual peculiarities. From the following figures it will be seen that the amount of jelly yielded, its melting point, and its keeping quality differ for each species.

	Parts required to gelatinize 1,000 parts of water.	Melting point of jelly.
Gelidium corneum	8	90° F.
Gelose	4	90° F.
Chondrus crispus	30	80° F.
Canagheenin	30	70° F.
Eucheuma spinosum	60	90° F.
Isinglass	32	70° F.
Gelatin	32	70° F.

It will be observed that Chondrus crispus is the only kind producing a jelly that will dissolve quickly in the mouth; but it has the unfortunate peculiarity of not keeping well. That of Eucheuma spinosum keeps remarkably well, and that of E. speciosum has been found to keep good, even in London, for six months.

The jelly of Gelidium spinosum (a Japanese species closely allied to G. corneum) possesses the disadvantage of melting at too high a temperature for use as a dietetic jelly, but it has a peculiarity that has been turned to account in the arts. It is capable of gelatinizing a larger quantity of water than any other known alga. In consequence it has been applied extensively as a medium for dressing silks in France under the name of "thao." It is said to preserve their suppleness at the same time that it gives them greater glossiness and softness to the touch. In the proportion of 1 part to 100 of water it is also used for giving substance to calico, a little glycerin being added if it be desired to render the material still more flexible. In pharmacy the use of Japanese isinglass has been suggested for the preparation of tannin suppositories, since it does not precipitate tannin.

A rather objectionable use of Japanese "isinglass" was detected some years ago in a very singular manner. Some fruit jelly was sold at an unusually low price, and it was noticed that the jelly seemed rather less readily soluble in the mouth than usual. Some difficulty was experienced in detecting the adulterant until a microscopical examination revealed the presence of a beautiful marine diatom, Arachnoidiscus Ehrenbergii, which gave the clew to the adulterant, for Japanese marine diatoms do not grow on French fruit trees! The more recent application of Japanese isinglass, under the Malay name agar-agar, as a cultivating medium for various Schizomycetes, is now well known.

The peculiar properties of Gelidium spinosum were found by Payen to be due to a body which he named gelose, and of which he described the chemical properties (*Compt. Rend.*, October, 1859). It differs from gelatin in being but slightly prone to undergo change, so little, indeed, that seaweed jelly containing it, sweetened and flavored ready for use, has been imported to this country from Singapore, and in this state may be kept for years without deterioration ("Hanbury Science Papers," p. 208, "Pharmacographia," 2d. ed., p. 680).

Gracilaria lichenoides is better known as Fucus amylaceus, and Ceylon or Jaffna Moss. It is a native of the Indian Ocean and belongs to a genus, the spe-

* Macrocystis pyrifera, found near Cape Horn, is said to reach a length of 1,500 feet (nearly one-quarter of a mile) and species of Lessoni a have quite arborescent stems (see Hook, "Fl. Antarct.," tab. 167-171, pp. 156-160).

* *Journ. Soc. Arts*, xxxii., p. 717; *Journ. Soc. Chem. Ind.*, v., p. 218.

† Mr. Stanford remarks that mannite is not present in the fresh plant, and is probably the result of fermentation.

cies of which deserve further chemical examination. It has been found to contain (by O'Shaughnessy) 54½ per cent. of mucilage, 15 per cent. of starch, 4¼ per cent. of a gum, and 7½ per cent. of salts. The plant was also examined by Mr. H. G. Greenish, who found that after exhaustion with cold water it yielded to boiling water a substance which made a firm jelly on cooling, and could then be cut into strips, washed white with water, but which differed in some respects from gelose.

The gelatinous constituent of Chondrus crispus has been described under the name of carrageenin, but it is doubtful if the substance examined was in a perfectly pure state, and its chemical relationships are at best ill-defined. The exact nature of the gelatin of the Eucheuma spinosum of the Indian Ocean and of E. speciosum of W. Australia has not, that I am aware of, been chemically examined.

In conclusion, I would suggest the following as points worthy of investigation in connection with marine algæ.

The presence of starch or gelatinous matter in some of the commoner British species, *e. g.*, Granlaria confervoides, Almfeltia plicatu, etc., the value as manure of different species (*e. g.*, it has been found that Halopithys pinastroides, which contains very little iodine, yields about 12 per cent. of potash); the nature of the pungent odors given off by certain algæ, *e. g.*, Monospora pedicellata, Griffithsia corallina, Spondylothamnion multifidum and Dictyopteris polypodioides; the cause of the rapid decay when removed from sea water of various Desmarecticæ, and of the nature of the decomposition which they cause in other algæ by contact, and the pungent principle (evident to the taste) of Laurencia pinnatifida. From a physiological point of view, the galls formed on Cystoclonium, Chondrus and Delesseriæ, etc., and attributed by Dr. F. Schmitz to the presence of bacteria; the vital and chemical process by which granular sulphur is deposited in the filaments of Beggiatoa, and the influence of currents and temperatures and local peculiarities on the distribution of species. For those inclined to the pursuit of systematic botany, I may mention that the comparison of the British marine flora with that of neighboring countries has led to the discovery on the part of myself and a few ex-workers (more especially Mr. E. A. L. Batters, of Wormley, Mr. W. H. Traill, of Edinburgh, and Mr. R. V. Tellam, of Bodmin) of nearly two hundred species previously unknown as British, and fresh species are still being added by a widening circle of algologists nearly every month. It is almost certain that the exploration of the Orkney, Shetland and Scilly Isles would add a considerable number. I may also point out that the reproductive organs of several species are still unknown. (See *Ann. Bot.*, vol. v., p. 534–536.)

SOME ECCENTRICITIES OF PLANT NUTRITION.*

Professor J. R. GREEN.

PLANTS take in certain inorganic constituents from the soil, and others from the atmosphere, but some do not perform this function of nutrition exactly in the same way as what may be called typical plants. The food of plants, as of animals, can be classified into nitrogenous and carbonaceous groups, and some special features of certain plants are connected with the manner in which they obtain a supply of nitrogenous compounds.

Thus, the sundew, Venus' fly-trap, and the different pitcher plants have their leaves adapted in various peculiar ways to capture insects. These are then apparently digested by means of secretions containing ferments allied to pepsin, and the animal matter is assimilated by the plants, which thus save themselves the necessity of obtaining nitrogenous food material in more orthodox ways.

Another group of plants includes the mistletoe, thesium, orobanche, cuscuta, and rafflesia, which are parasitic in a greater or less degree, obtaining all or some of their food from the host plants upon which they develop or to which they attach themselves. Other plants of similar appearance to these vary in habit, living on decaying organic matter, and being hence known as saprophytes.

A subject of much greater importance, however, is the problem which agriculturists have had to face of late, as to whether plants can to any extent avail themselves of the nitrogen in the air. While nitrogenous manures increase the produce of most agricultural crops, they do not so affect the *Leguminosæ*. Leguminous crops accumulate in themselves more nitrogen than any other crop, and contain a higher percentage of nitrogen in their dry substance. Allowing that by their deep roots they draw a good deal from the subsoil, this does not explain the accumulation.

Mr. Boussingault, fifty years ago, proved that plants do not, under ordinary conditions, utilize the free nitrogen of the air, and his results were confirmed later by other observers, particularly Lawes and Gilbert. Where, then, do the *Leguminosæ* get this excess of nitrogen? Hellriegel's experiments in 1883 are of great importance in this position of affairs. He commenced then a series of vegetation experiments in pots, in which he grew agricultural plants of various families in washed quartz sand, giving them various nutritive solutions, but no nitrogen in some and known quantities in others. In all except the *Leguminosæ* he found the growth of the seedlings was proportional to the nitrogen in the seed and that supplied in the solution. It was different with the *Leguminosæ*. Taking a series in which no nitrogen was supplied, most of the plants were limited in their growth by the amount of nitrogen in the seed. Some, however, growing apparently under the same conditions, were much more luxuriant, and he found that certain curious nodules were present on the roots of these. Further experiments, conducted later, showed that plants could be infected with these nodules, and that then they grew luxuriantly, though no nitrogen was supplied to them. Ordinary soil in which these plants grow contains the infecting material. Taking similar pots as at first, with no nitrogen in the soil, and watering some of them with an extract of the infected soil, the plants in the latter grew well and developed nodules, while the unwatered ones did not. Boiling the extract caused it to be useless for infection.

In 1888, 1889, 1890, and 1891, Dr. Gilbert and Sir J. Lawes repeated Hellriegel's experiments on many kinds of leguminous plants and obtained the same results. By the kindness of Dr. Gilbert I can show your representations of plants grown under these conditions. 1. Plant (lupin) grown in quartz sand, kept at boiling water temperature for several days, nothing added; 2 and 3, the same, with extract of garden soil added; 4, plant grown in ordinary sandy soil; 2, 3, and 4 showed great growth, and all had nodules on their roots.

Another series of plants, in this case sainfoin, was so arranged that the plants could be examined as to nodule development during their growth. They were grown in pots in the open air, one set being in sand, watered with an extract of rich soil, and the other in mixed soil and sand. The plants were examined at four periods. 1st, at the end of the first year. 2d, in the second year, when active vegetation was established. 3d, when the period of maximum accumulation was reached. 4th, when the seed was nearly ripe. The experiment showed that infection with soil extract was not so effectual as that coming from the soil itself. In the sand the infection was local and limited, but some of the nodules developed to a great size on the roots of the weak plants. The series showed, as did the other, that the absorption of nitrogen by the *Leguminosæ* is associated with nodule development and varies with it.

The Fungus of Vicia Tubercles.—The tubercles on vicia are formed without any order, on the tap root and lateral roots, especially affecting the region where the ro t hairs are in full vigor. They may be only few or many, crowded or scattered. They soon swell and become lobed in various ways. Their color and texture are like those of the rest of the root. A longitudinal section through the tubercle shows its chief mass to consist of rather large polyhedral parenchymatous cells, passing at the apex into smaller closely packed thin-walled cells. In the large-celled axial tissue the parasite is rampant. The hyphæ can be traced through the cells of the section, showing a curious trumpet-shaped swelling where they penetrate the cell walls. They are thicker in the epidermis and cortex than further inward. As the tubercle becomes older those in the cortex turn yellowish and gradually decompose, so that no trace of them can be detected in the larger tubercles which have broken through the cortex of the root. In the cells of the young tubercle the finer branches of these hyphæ can be seen passing through the walls and across the cavities of the cells. The ultimate branches end blindly in these cavities, and terminate in the tufted bodies which look like haustoria or sucking branches. Numerous very fine protuberances stand off from the rest of the mass. Almost every cell of the actively dividing tissue of the tubercle seems to contain them. Then the protoplasm of these cells becomes frothy, and is found to be gradually charged with bacterium-like corpuscles, increasing in number till the cells are full of them, so full indeed that they eventually obscure the appearance of the hyphæ.

These bacterium like bodies seem to be budded off from the hyphæ as shown, and then multiply further by budding in the cells. Hence they are V or Y shaped. The irritation set up by these causes the cells to grow, and so the tubercle hypertrophies. It then passes into a state of rest, and later rots, liberating the bacteroids into the soil, causing subsequent development of new tubercles in roots growing to the soil in which they are. This explains the infection of fresh plants when dressed with an extract of the soil in which the plants have been growing, as already described.

Fresh roots can be infected either by such an extract or by putting pieces of the tubercle upon them. They will stand drying and remain dormant for months. When a root is infected by either of these methods a long period of incubation is noticeable, sometimes as long as five weeks. When infection takes place it is noticed to begin with the root hair. The hypa running down this hair starts from a bright dot, which is probably one of the bacteroids or germs. From this point the progress of the hypha is seen in the sections already shown. The fungus, according to Marshall Ward, is probably a member of the *Ustilagineæ* or smuts, the behavior of the mycelium agreeing with those of the latter. Professor Ward remarks, "I regard the fungus as one of the *Ustilagineæ*, which has become so closely adapted to its life as a parasite in the roots of the *Leguminosæ* that it has come to stimulate and tax its host in an exquisitely well balanced manner, and has lost its needless true resting spores, because the more numerous and tiny sprouting gemmules are kept in the cells of the tubercle through the dry summer and autumn, and freed during the rotting in the soil in the winter and spring. Their very minuteness and numbers enable these germs to become as ubiquitous as bacteria or ordinary yeast forms, thus explaining the ubiquity of the tubercles."

Fixation of Nitrogen.—The theories advanced are as follows: 1st. That the fixation takes place in the soil under the influence of the microbes, and that the higher plant absorbs the resulting combined nitrogen. This is rather opposed by the fact that in the experiments with peas in 1888 there was no gain of nitrogen in the soil, but supported by Schloessing and Laurent, who have shown fixation in bare soil and soils growing various lichens and algæ. The matter is therefore unsettled, but the evidence is rather against than for the theory. 2d. That under the conditions of the symbrosis the plant fixes the nitrogen of the air by its leaves. There is little or no evidence to support this theory. 3d. That the free nitrogen is fixed in the course of the development of the organisms within the nodules, and that the resulting nitrogenous compounds are absorbed and utilized by the rest.

* Notes of a recent lecture delivered at an evening meeting of the Pharmaceutical Society, London.

AMERICAN HISTORICAL EXPOSITION—MEXICAN SECTION—THE GOD TZONTEMOC.

THE AMERICAN EXPOSITION NOW OPEN IN MADRID—THE MEXICAN HALLS.

THE republic of Mexico responded nobly to the call that was sent to all the Americas for exhibits for the important exposition that we are now considering. She sent to us those of her students of the historical sciences, of whom there is a legion in Mexico, who are best fitted for the work. The director of the National Museum, Mr. F. del Paso y Troncoso, was selected to preside over the commission, one of the members of which is a clergyman, Mr. Francisco Plancarte, who is as modest as he is learned, and one of the most active collectors of the antiquities of his country. Naturally, Mr. Plancarte brought his collections to Spain with him, and they constitute the greater part of the Mexican exhibit, being its most important contingent.

Objects of such great value should hold a conspicuous place in the Palace de Recoletos, and in fact Mexico occupies five of the large halls of the edifice. In the extent of her exhibit she is surpassed by none of the other republics, and is equaled only by the United States. In regard to importance, I would not dare to say as much, for, although the North American exhibit is very interesting, it lacks unity in the series, continuity in the objects and system in the arrangement, all of which conditions are fulfilled in the Mexican halls with notable effect.

On account of incomprehensible administrative delays in the American Exposition, no catalogue of the objects contained therein is yet ready, and the great

majority, or rather I should say nearly all, of these objects are unmarked by explanatory labels, so that visitors leave without knowing their names or learning their use or significance. And this threatens to last until the Exhibition is closed, unless the activity employed in less important work is soon directed to this publication, for which every one asks, and the place of which has been only imperfectly filled by some partial lists and summaries.

Thus we have to pass through Mexico without any guide except Mr. Plancarte's catalogue that has just been published in the capital of that republic. This catalogue, which was doubtless made in great haste, does not give details about the 2,802 objects, limiting itself to a summary explanation of their form, material, derivation and dimensions, without stopping to define the proper names, the special significations, nor the inherent symbolisms.

The Mexican exhibit is situated on the lower floor of the Palace de Recoletes, five halls being, as I have said, devoted to it. The first is occupied by reproductions in plaster of colossal stone idols belonging to the National Museum of the republic. There is seen the circular stone that represents Tzontemoc, the god of darkness, with a high diadem that reminds one of an Assyrian head dress, and the complicated symbolic ornaments; and there the goddess Coatligue, whose head is hidden in a great hood, and who is represented with human hands and the feet of an animal. Her garments are formed of intertwined serpents and her girdle is decorated with an animal's head. The breast, which is bare, denotes the sex of the figure. We also find here the god Tezcalzontalt, of the Nahua races, colossal in proportions, reclining, rather than sitting, so as to support with both hands the vase in which he received the offerings of the faithful, wearing, as his only garments, the diadem of Maya characters, wide bracelets on his arms, hoops in high relief, that must have been of gold, below the knees and on his ankles, and sandals with thick soles that remind one of the *gueta* of the Japanese. The statues of these divinities are interesting and curious, but they are not sufficient to give an idea of the pantheon of the ancient gods that were once an object of veneration and worship to the Indians of Central America.

While the races of the north were capable of developing only a simple and primitive religious idea that corresponded with the extreme simplicity of their representations and external formulas; among the central races, from the Maya nations that lived in Tabasco, Yucatan, and Guatemala, to the primitive races of Ecuador and Peru, complete mythologies with their corresponding and complicated forms of worship were developed. The Mexican religion consisted of an exaggerated polytheism, with hundreds of divinities with different functions and various attributes, that are known to us by the imperfect accounts of ancient travelers. The Mexicans knew their gods by their heads, and the Egyptians classified theirs in the same way, a coincidence of history which, however, proves nothing in favor of the common origin of the peoples. Near the gods, in this same hall, is a representation of priests. These were in Mexico ministers of the altar, masters of their science, soothsayers, and physicians understanding the remedies for material infirmities. An image half the natural size represents a priest found in the state of Chiapa; he wears a monumental diadem with elaborate ornaments; his arms are folded on his breast and he holds in his hand one of the innumerable adornments of the Maya worship; around his waist is a kind of stoll which hangs from his left side, and he wears other adornments which are the exterior signs of the functions that he exercises in the precincts of his temple.

There are some reproductions of these Mexican temples in the Exposition, but more interesting than these, in my judgment, are the representations of what they contained, because they open pages of history and infinite details of the lives of those believers who prostrated themselves at the foot of their altars. Thus I saw with great pleasure the interesting Maya stone, also from the state of Chiapa, that bears the representation of a captive of war bound at the foot of the symbolic column. His expression is fierce in spite of the rudeness of the sculpture, which, however, fulfills the principal requirements of artistic canons. On his flesh are characters that, when they can be read, will tell us to what nation or race the captive belonged, in the same way that the representations of captives in those famous reliefs in the temples of Medinet Abu enabled us to construct the long series of brilliant exploits of the conquerors of Sesostris in Asia Minor. The posture of the Mexican image could not be more expressive, but in regard to its significance we can know nothing with certainty until the problem of the Maya writing is solved.

The collection of Mr. Plancarte consists of 2,802 objects, all of great importance. There is no doubt of the authenticity of any of them, for all, or the great majority, came from excavations or explorations conducted by the collector himself. Mr. Plancarte began by collecting a few bones, a little clay idol, arrow heads, knives and other articles found in building a railroad across the Jacona River to the city of Zamora. His second expedition was directed to a place near the source of this river, where he found only arrow heads and unimportant earthen pots.

His third expedition was more successful. He then went to the southern end of the Valley of Zamora, called Los Gatos, where he discovered an extensive Indian necropolis containing 48 skeletons, some reclining and some seated. Among the isolated tombs he found walls made of stones placed one upon the other without mortar of any kind, forming a square inclosure that was filled with human skeletons, clay vessels, instruments and arms made of stone and of copper and ornaments made of various substances. In one corner of the inclosure was an adobe structure that was almost calcined and contained carbonized remains of human bones and instruments of shell, thin sheets of gold, fragments of gilded disks and pieces of cloth that probably clothed the skeletons before they were reduced to ashes in that furnace.

Three leagues from this place, where he made other excavations, Mr. Plancarte found the site of the ancient city of Jacona, the ruins of which are still visible, those of the large temple being prominent objects. This curious structure he had reproduced in wood. In these excavations skulls and very curious objects of clay and copper were found.

Finally, Mr. Plancarte availed himself of the good offices of his friends, enriching his collections by contributions sent from Pajacuaran, Jacona, Santiago, Tangamandapio and several other places.

The Plancarte collection is divided into fifteen groups, forming a most interesting subject for study for those who can visit the Exposition.—*La Ilustracion Artistica.*

AMERICAN HISTORICAL EXPOSITION—MEXICAN SECTION—THE GODDESS COATLIGUE.

AUSTRALIAN HAIL STORMS.*

SOME recent thunder and hail storms were so violent that they call for more than a passing notice, not only on account of their severity, but also because they are well-marked phenomena in our weather. The district in which they were most severe is that around Narrabri, and the weather map for the day indicated this district as one in which storms would probably manifest great intensity. The places from which the best accounts have reached me are Narrabri, Avondale, thirty miles due north of Narrabri, and Tulcumbah, fifty-seven miles southeast of Narrabri.

The Sydney weather chart at 9 A. M. on October 13, the day of these storms, shows us that there was but little difference in pressure all over Australia. To the west of the overland telegraph line it was slightly higher, over western New South Wales and Queensland lower, and higher again over the east coast, in which the isobars clearly outline the area of relatively low pressure, and the kinks in them indicate disturbed conditions, local short-lived storms, and before the day was over the inference from the state of pressure was fully justified, for storms of extreme violence occurred over the area; storms which swept down great forest trees two and three feet in diameter. What this means in wind velocity I am unable to say. The trees are eucalypts, and therefore the wood is hard and very strong, but they were treated as if they were reeds, and their strength was as nothing compared with the force of the wind.

These storms are common enough, but owing to the sparse population they seldom pass over towns or dwellings. In this instance such has been the case, and in the future as population increases similar cases must increase in number, for the storms are abundant, indeed these storms form a well-marked feature of our summer weather. As a rule they are disconnected, and the most violent part of the wind covers but two hundred or three hundred yards wide, and travels along with great rapidity, leaving a narrow line of destruction in its wake.

On the day in question heavy storms were reported at Goodooga, Armidale, 240 miles southeast of Goodooga, and at Grafton, 100 miles northeast of Armidale. Storms which seem to have been quite disconnected, for the earliest time was at Grafton, and as a rule they come from the west; these are spoken of as severe storms, but were evidently not specially remarkable—nothing to compare with those in the Narrabri district, to which I wish to direct your attention. Unfortunately, data for determining the rate of progress are not available, although that as to the intensity of the storms is abundant. I may mention that three days before these storms, that is on October 10, a similar storm passed over from Wilcannia to Sydney, a distance of 480 miles, at the rate of 55 miles per hour; and I have before traced one over the same part of the colony, the rate being 57 miles per hour, but we have not traced a sufficient number to determine an average rate.

As to the velocity of the wind along the line of damage in these storms, we have no actual anemometer results; so far we have not had one which passed over one of the anemometers, but judging from the damage done to large and solid trees, two and even three feet in diameter, it cannot, I think, be less than 140 or 150 miles per hour.

We may now turn to the storms in the Narrabri district. The storm reached Narrabri at 6:15 P. M., and the postmaster reports that the storm which approached Narrabri from northwest was accompanied by thunder and lightning, but no hail. The wind, however, seems to have been of hurricane violence. Trees two feet in diameter were torn up by the roots, limbs 12 inches through were snapped off short, a brick factory completely ruined, roofs, signboards and everything that the wind could move went flying; in the language of the local newspaper, "substantial brick buildings came tumbling in all directions, the air was full of iron tubs, galvanized iron and tins of every description."

In the district south of Narrabri the storm was even more severe. At Tulcumbah Station, 57 miles southeast from Narrabri, at 8 P. M. on October 13, a violent thunder and hail storm broke over the homestead. It lasted half an hour, and Mr. A. D. Griffiths, my informant and manager of the station, says: "I meas-

* Read by H. C. Russell, F.R.S., before the Royal Society of N. S. Wales, November 2, 1892.—*Nature.*

ured some of the hailstones, 6½ inches in circumference; this was 15 or 20 minutes after the storm, and I think I did not get the largest. Next morning I found that 19 sheep had been killed by the hail, also birds, kangaroo rats and other animals were found lying dead in all directions. All the windows exposed to the storm were broken, and the galvanized iron roofing is dented from end to end, and many sheets cut through. In several cases the hailstones went through the iron; in one sheet I found 30 holes and in another more than 60. The bark of the trees in the storm track was all battered by the hail, and the fences and buildings bore traces of the impact of these great lumps of ice. The stones were generally triangular or conoidal in form, many having an uneven surface, which looked as if it had been formed from frozen drops of water collected into masses; others had an opaque, snow-like center. Perhaps the majority were like this, the remainder being like clear ice. It was only the larger stones that were irregular as described; the smaller ones were generally rounded."

At Avondale, thirty miles north of Narrabri, my informant, Mr. S. J. Dickson, says: "From the 9th to the 13th of October the weather was unusually oppressive, with threatening storms, and on the evening of the 13th a heavy storm was seen to be working up from the west, accompanied by incessant lightning of every description, and about 8 P. M. it broke over the homestead in all its fury. The wind was from south-west and of terrific force, and the rain and hail were very severe. The hailstones were as large as hen eggs, and in some of the paddocks, one particularly, it pounded the herbage completely out, so that not a vestige of it was left, although before the storm came on it was from 6 to 12 inches high, and in other places strong variegated thistles 3 to 4 feet high were beaten down. Trees some 2 feet thick, that the wind could not tear up by the roots, were snapped off short, as if made of matchwood. In the storm the hail killed birds innumerable, and even domestic fowls roosting on the trees were killed by it, and after the storm a large snake was found cut into two pieces by the hail, so at least it appeared. On the open plain the hail lay 4 to 6 inches deep, and the whole country looked as if a heavy snowstorm had passed over it. Trees in the track of the hail were completely denuded of leaves, and the bark knocked off tree trunks and limbs. The storm wind carried away outstations, unroofed the hayshed, damaged the woolshed and carried away two sides of the house veranda, and the sheets of iron from it were found nearly half a mile (30 chains) away to the northeast. Round wall plates in the hayshed 6 to 8 inches thick were broken to pieces, and the iron roofing on all the buildings was battered by the hail as if some one had pounded it with a hammer all over. The storm track was only a mile to a mile and a half wide, at least the hail part. Between 7 and 8 P. M., as the storm came up, there seemed to be a white bow in the sky, like a white rainbow stretching from north to south. I have seen heavy storms before, but I never wish to see another like this. The shearers were completely terrified, and all say that they have never experienced a storm like it. In fact, it beggars description and can hardly be realized. It was an experience that we shall remember as long as we live."

North of Narrabri, and especially between Narrabri and Avondale, the storms were very severe. Midway between these places and at Terry-hi-hi and Berrigal Creek the wind worked great destruction in the forest. How violent it was may be gathered from the fact that great trees 12 feet in circumference at 3 feet from the ground were snapped off short 10 feet above the ground, or entirely stripped of their limbs.

GASES IN LIVING PLANTS.

By J. C. ARTHUR.

PLANTS are permeated by the same gases that make up the atmosphere surrounding them: oxygen, carbon dioxide, and nitrogen. Nitrogen in the form of a gas is neither used nor generated by any part of plants, unless we except the tubercles of certain roots, and so it occurs in about the same percentage inside the plant as outside of it. On the other hand, both oxygen and carbon dioxide enter into combination with, and are liberated from, the plant tissues in varying amounts at different times. The percentage of these two gases in the cavities of the plant varies through a considerable range. In a series of determinations made by Lawes, Gilbert & Pugh, in England, the oxygen ranged from 3 to 10 per cent. and the carbon dioxide from 14 to 21 per cent. in plants which had been for some time in the dark, while plants which had been standing in sunlight reversed these figures, and gave 24 to 27 per cent. of oxygen and 3 to 6 per cent. of carbon dioxide. The two gases, therefore, bear a somewhat reciprocal relation, their sum usually being about 25 to 30 per cent. of the total gas in the plant.

The variations in the relative amount of oxygen and carbon dioxide are due to two independent processes incident to the life of plants. One of these processes is assimilation, by which all green cells of plants in the presence of sunlight or its equivalent, such as a strong electric light, absorb carbon dioxide and liberate oxygen. This process goes on with great rapidity in healthy cells, but is entirely checked upon the withdrawal of light, or when it reaches a certain low intensity. Of course it never takes place in roots, flowers, the central portion of large stems, or other parts which are not green, nor in any fungi or other plants not possessed of green coloring matter.

The other great cause of disturbance in the relation of oxygen and carbon dioxide in the plant is the process of respiration.

Respiration in plants is essentially the same as in animals, and consists in a fixation of oxygen and the liberation of carbon dioxide. It takes place in every living cell, whatever the kind of plant, whatever the part of the plant, and whatever the conditions of active existence. The rate of respiration varies with the temperature, the age of the cell, and the nature of the chemical transformations. In normal respiration the amount of oxygen absorbed is approximately the same as the amount of carbon dioxide evolved. There are, however, certain modified forms of respiration in which this does not hold true.

If living plants be placed in a vacuum, or in an atmosphere deprived of oxygen, it is found that they can still carry on life processes for some time, accompanied with an evolution of carbon dioxide. The oxygen necessary for this process is obtained from the breaking up of compounds in the cells, and it is therefore called intramolecular breathing.

The germination of seeds, which contain a large amount of oil, is somewhat the opposite of this last process. In order to convert the fat into a more directly serviceable food material for the plant, a large amount of oxygen enters into the new combination, for which there is no equivalent amount of gas liberated. It consequently comes about that oily seeds in germinating absorb a far larger amount of oxygen than they liberate of carbon dioxide. This is known as vincular breathing.

Another variation from normal respiration is known as insolar breathing. This, with still some other modifications, I need not stop to explain. To this brief statement of plant respiration must be added that much yet remains to be discovered regarding the details of the processes.

Assimilation and respiration are the two great causes which disturb the relative volume of the two variable gases in plants.

We shall now turn to the movement of the same two gases, oxygen and carbon dioxide. There has never been a disposition, as in the case of many other plant phenomena, to explain the movement of gases upon any other than purely physical principles. We have therefore to do simply with the question of the aids and hindrances to the establishment of an equilibrium between the gases inside and outside the plant, irrespective of whether the cells are alive or dead.

It has already been stated that the relative amounts of oxygen and carbon dioxide inside the plant are usually very different, and that within a few hours the relation of the two may be completely reversed. To this may be added that the pressure of the gases inside the plant is sometimes more, sometimes less, than that of the atmosphere outside the plant, almost never the same. Hales observed in his early work that a mercury gauge connected with the inside of the trunk of a tree showed an internal pressure when the hot rays of the sun warmed the trunk. This was largely due, undoubtedly, to an expansion of the gases in the trunk by the heat. Such an excess of pressure in water plants is very common, although due to other causes. It may readily be shown by breaking stems under water, when bubbles of gas will be liberated, as undoubtedly many have noticed in gathering water lilies, or other water plants.

On the other hand, the pressure of the gas inside the plant may be less than on the outside. This has long been recognized, but was best demonstrated by Von Hohnel, in 1879, to whom it occurred to cut off stems under mercury. In doing so the mercury rose to a considerable height in the vessels of the stem, and as mercury is without capillarity, this can only be ascribed to the greater pressure of the outside air, or, in other words, to a partial vacuum in the plant.

An observation was made by Hales, which we may use to illustrate how such a negative pressure, as it has been called, can be brought about. He cut off a branch, fastened an empty tube to the cut end, and plunged the other end of the tube into a liquid. He found that as evaporation of moisture from the leaves took place, the liquid was drawn up into the empty tube. This phenomenon can now be explained more satisfactorily than could be done at that early day. By evaporation the liquid water inside the plant escapes in the form of vapor, and the space it occupied is filled by the gases, thus rarefying them. This rarefaction may go on in uninjured plants until the internal pressure is greatly reduced. But in the experiment, the pressure is equalized by the rise of the liquid in the tube. A later modification of Hales' experiment is to use a forked branch, place the cut end in water to give a continuous supply of moisture for transpiration, and attach the empty tube to one of the side forks of the stem cut away for that purpose.

It is self-evident that such condensation and rarefaction of the gases in the plant could not take place if the cell walls were readily permeable to gases. Thus it comes about that one of the most important topics in connection with the movement of gases in the plant is the permeability of tissue walls of various kinds, and especially those constituting the surface covering of plants.

I shall not attempt to conduct you through the tangle of supposition and fact, errors in experiments, correct and incorrect conclusions, and the general confusion which has come from the labors of physicists, chemists and botanists for the last twenty-five years, during which the subject has received particular attention. The results of the later work have been to cast grave doubts upon the correctness, or at least the interpretation of some of the experiments most relied upon heretofore. Nevertheless, many points still lie open for verification, and untouched parts of the subject await investigation.

In the earlier days it was found that the leaves and young stems of plants have their epidermis more or less well supplied with minute openings, called stomata or breathing pores, communicating with small air cavities inside, which in turn branch out among the cells into a network of minute passages ramifying throughout the plant. This intricate network of intercellular passages affords an air communication throughout the whole plant, and a direct connection with the outside atmosphere through the stomata. Subsequent to the discovery of stomata, it was ascertained that in stems more than one year old the stomata are replaced by another kind of openings, known as lenticels, which in some form are doubtless to be found in the bark of shrubs and trees of whatever age.

Gases stream into and out of the plant through the stomata and simpler lenticels, according to the law governing the movement of gases through minute openings in thin plates. The rate of movement is accordingly proportional to the square roots of the density of the mixing gases. Such a movement of gases is known as effusion.

The movement by which gases pass from one part of the plant to another, through the intercellular spaces, is governed by other laws. It was at first thought that the rate of movement would correspond to that in capillary tubes, according to the well-known law of Poisenille, that it is proportional to the fourth power of the diameter, divided by the length of the tube, but upon testing the matter two years ago, Wiesner found that owing to the extreme minuteness of the intercellular spaces, and their zigzagged and branched condition, this law does not hold, neither does the movement prove to be proportional to the density of the gases. The law of the rate of movement of gases in intercellular spaces, that is, the transpiration of gases, is, therefore, yet to be discovered, together with other interesting facts pertaining to the subject. Poisenille's law does, however, hold good for the movement of gases in the woody ducts, but here it is of limited application, for these do not connect with one another, with the intercellular spaces, or with the exterior of the plant.

The walls of most cells, ducts, and the surface covering of plants, except as already mentioned, are imperforate, that is without any openings that can be demonstrated by the microscope. If gases pass through them, it must be in accordance with some law of diffusion or osmosis. Many experiments in this line have been tried, and the results have been of the most diverse character. It is impossible to give a fair idea of the subject in the space at my disposal, and it must suffice to mention a few bare facts.

The most astonishing and important results were obtained by Wiesner, in experiments conducted at Vienna, two years ago. It would be a most natural interpretation, it seems to me, to think that the gases are forced from one cell to another, through the cell walls, by differences in pressure. Wiesner found, however, that it is impossible to force gases through cell walls of any kind whatever, by any pressure they will stand, acting for any length of time. For instance, a bit of grape skin held up a column of mercury, seventy centimeters high, for seventy-five days, and a piece of cherry skin withstood a pressure of three atmospheres for twenty-four hours. Similar experiments were tried with cuticularized, suberized, lignified, and simple cellulose tissues from many sources, and with uniformly the same results, whether the tissues were moist or dry, alive or dead.

But in the same set of experiments it was found that if gases cannot be forced through cell walls, they will readily pass through by simple osmotic diffusion. All cells permit the passage of gases by diffusion when moist, dependent upon the coefficient of absorption and the density of the gas. Cuticular and corky formations also permit the passage of gases when dry. Thus we see that gases may be forced through the stomata or breathing pores, by varying pressure, but can only pass through the epidermis and bark of plants by diffusion. We therefore arrive at the conclusion that the gases inside and outside of the plant are brought to an equilibrium by direct interchange through the stomata and intercellular spaces, aided by the comparatively slow process of diffusion through the whole surface of the plant, both above and below ground.—*Amer. Naturalist.*

BEHAVIOR OF SOME METALS WITH GASES.

By G. NEUMANN.

THE portion of this investigation relative to hydrogen has been executed by the author in conjunction with F. Streintz. Their attention was drawn to the question by the view that lead as the negative plate of a secondary element is capable of occluding hydrogen.

A proof for the correctness of this view could not be obtained by direct electrolytic experiments, as the arrangement of the experiment proved too difficult. Better results were obtained on allowing pure, dry hydrogen to pass through melted lead in a U tube.

After the gas had been passed for a considerable time, the excess was driven out by nitrogen. Oxygen was then passed through, and this again was expelled by dry air. The water formed by the action of oxygen was received in calcium chloride tubes and weighed, and the quantity of hydrogen absorbed by the metal was thus calculated. In two experiments which could be regarded as successful the result was, in one case, 0·15 times the volume of the metal, and in the other, 0·11 times. Hence the occluding power of lead for hydrogen seems demonstrated.

The next experiments were made with palladium. This metal, as is well known, occludes hydrogen very greedily. The experiments, as well as those with other metals still to be mentioned, were executed in an analogous manner to those on lead, *i. e.*, the dry hydrogen was passed over the heated metal. The metal was used as palladium black. Hydrogen was absorbed to the extent of 502·35 times the volume of the metal.

Platinum was examined as platinum sponge and platinum black. The latter acts more energetically, is raised to redness by absorption without the application of external heat, as is palladium by the absorption of oxygen. Platinum sponge occludes 49·30 times its volume of hydrogen. This figure varies considerably from that found by Graham. For an explanation of this difference we must refer to the original.

Gold occludes relatively much hydrogen; the action of oxygen upon the metal charged with hydrogen is not very strong. In two experiments there were obtained, respectively, 46·32 and 37·31 times the volume of the metal. Here also the values were decidedly higher than those ascertained by Graham. The latter used gold from so-called assay rolls, while the authors employed a preparation obtained by precipitating the chloride with oxalic acid.

Silver absorbs, according to the author's experiments, no hydrogen, while, according to Graham, silver wire occludes 0·211 times its volume. Aluminum absorbs 2·72 times its volume of hydrogen in thin sheets previously purified.

Iron in a state of fine division absorbs 19·17 times its volume. Copper occludes about four and a half times its volume.

Nickel, which in its chemical properties is intermediate between copper and iron, behaves similarly in its occlusive power for hydrogen. It occludes 17·57 volumes.

The absorption of hydrogen by cobalt is rather

large, and the metal when charged with hydrogen becomes incandescent in a current of oxygen.

The occlusive power of some metals for hydrogen decreases on a repetition of the experiments. The authors explain this in the noble metals by an increase of density. This occurs according, also, to Graham. Copper and nickel on a repetition of the experiment show the same occlusive power. In the case of iron and cobalt, which behave like the noble metals, the authors have not yet found any explanation.

Neumann has examined the behavior of the precious metals with oxygen by a method analogous to that above described.

The metals were ignited some hours in pure oxygen, two calcium chloride tubes were then attached before the occlusion tube, and a potash apparatus to observe the rapidity of the gas; the oxygen was displaced by air, and this, again, after cooling, by nitrogen. After the current had passed for half an hour, hydrogen was introduced and heat was applied. The water formed was received in the calcium chloride tubes, which were weighed after they had been successively traversed by nitrogen and air.

Silver on being thus treated absorbed 4·09 vols., which does not agree badly with Graham's result, according to which from 6·15 to 7·4 vols. were absorbed.

Gold absorbed 48·49 vols. of oxygen, while Graham observed no absorption. Neumann believes that this difference may be explained by the temperature of the experiment.

In case of platinum, concerning the absorptive power of which for oxygen there is much discrepancy among former observers, Neumann found occlusion of 77·14 vols. With palladium the author found a formation of sub-oxide, since the residue after treatment with oxygen contained 6·99 per cent., while Pd_2O contains 7·33 per cent.

Neumann considers that the absorptions of oxygen depend on a power of the metals to become oxidized at about 450°, the temperature of the experiment.—*Zeit. Anal. Chemie*, vol. xxxii., p. 72; *Chem. News*, March 10, 1893; *Am. Jour. Pharm.*

ABSTRACTS FROM THE FRENCH JOURNALS.*

Preparation of Hydrobromic Acid.—E. Leger gives the following two processes in *Jour. de Pharm. et de Chim.* (February, 1893, p. 188):

Introduce KBr into a retort and heat on a water bath until the salt has attained a temperature of 100°; then add sulphuric acid drop by drop, which causes the hydrobromic gas to become disengaged. However, a small portion of bromine and of sulphurous acid is also liberated. The gaseous mixture is purified by being passed first over a saturated aqueous solution of HBr, containing an excess of bromine. In contact with this solution, the acid S_2O_4 becomes oxidized according to the equation:

$$S_2O_4 + 2Br + 2H_2O_2 = S_2O_6H_2 + 2HBr.$$

Then the mixture is passed over a saturated aqueous solution of HBr, to which amorphous phosphorus has been added, when it loses all the bromine and is perfectly pure. The gas is dissolved in a distilled aqueous solution of HBr. The acid is nearly colorless and contains no trace of $S_2O_6H_2$.

The second mode of preparation of gaseous HBr is by the action of S_2O_4 on Br, in presence of a saturated solution of HBr. The S_2O_4 is passed into a mixture of equal volumes of Br and saturated solution of HBr, when an abundant and regular disengagement of HBr will be obtained, which can be freed of Br and the small quantity S_2O_4, by passing over the purifying solutions previously mentioned. $S_2O_6H_2$ forms at the same time with HBr, and if in sufficient quantity the liquid will separate into two layers.

Solubility of Salicylic Acid.—The employment of salicylic acid to obviate the inconveniences and accidents in surgery and obstetrics due to the use of mercuric chloride is unsatisfactory, because of its sparing solubility. Carcano and Cesaris (*Boll. Farm.*, through *Jour. de Pharm. d'Anvers*, February, 1893, p. 55) propose to associate boric acid with salicylic acid, in the following proportion: Boric acid, 12 p.; salicylic acid, 6 p., and water, 1,000 p. This borosalicylic solution has the double advantage of being non-poisonous and acting as a microbicide.

Pill Coating.—The following is M. Fauel's method: The pills are uniformly moistened with a liquid composed of one part of glycerin and two parts of strong alcohol; they are then rolled in a sufficient quantity of impalpable powder, composed of saccharin, 4 p.; gum tragacanth, 2 p., and potato starch, 1 p. Remove the excess of powder by means of a sieve, and repeat the operation. To have the pills white, they are then moistened with glycerin, 1 p.; ether, 2 p., and rolled in a powder composed of equal parts of talc and carbonate of calcium.

The following are the author's formulas for respectively cacao and gelatin coating: 1. Cacao, 2 p.; saccharin, 2 p., and gum tragacanth, 1 p. 2. Gelatin, 11 p.; saccharin, 5 p.; distilled water, 24 p.—*Pharm. Weekblad*, through *Jour. de Pharm. d'Anvers*, February, 1893, p. 56.

Laxative Pills.—A. F. Philippeau gives the following formula in *Jour. de Pharm. et de Chim.*, February, 1893, p. 248.

Cascara sagrada, 5 cgm.; extract of nux vomica and extract of belladonna, of each, 1 cgm.; powdered ipecac and podophyllin, of each 1 cgm. For one pill, to be taken at night before retiring.

Preparation of Chlorhydrosulphate of Quinine.—Dissolve in the cold 30 parts crystallized quinine sulphate in 24 cc. hydrochloric acid (1·050) and allow the solution to evaporate spontaneously in dry air. A gelatinous layer separates which rapidly forms a hard mass of small agglomerated needles. The salt is very soluble in water, dries again in dry air and loses three molecules of water at 100° C.—*Comp. Rend. de l'Acad. d. Scien.*

Potassium Iodide Ointment.—Working by the following process a large proportion of potassium iodide can be incorporated with the base. The iodide is pulverized and dissolved in a sufficient quantity of hot glycerin (1 gramme to about 2·50 grammes glycerin); then mix this solution with petrolatum. The solution can be preserved for a long time if kept in yellow glass bottles.—*Bull. de la Soc. de Pharm. de Lyon.*

Test for Iodates in Alkali Iodides.—Dissolve 2 grammes of the suspected iodide in 25 cc. of boiled distilled water, shading it from too strong a light. Add a little starch, then 10 cc. tartaric acid solution, when, if an iodate is present, a blue color will be *immediately* formed.—*Robineau and Rollin, in Jour. de Pharm. et de Chim.*, December, 1892.

Preparation of Camphor by Means of Ozone.—M. De Mare utilizes the oxidizing properties of ozone or ozonized air for the preparation of camphor from camphene. The camphene is distilled, the receiver heated, and on submitting it to ozonized air, the camphor begins immediately to sublime on the sides of the cylinder. The camphor thus obtained is identical with the high priced Japan article.—*Lumiere Electrique.*

Preservation of Medicinal Distilled Waters.—M. E. Crouzel (*Bull. de la Soc. de Pharm. de Bordeaux*, January, 1893, p. 17) considers the principal causes of alteration, the use of non-sterilized containers, exposure to air, contact with organic material, and principally filtering through paper. To avoid this latter cause he proposes, if filtering paper is to be used, to first pass a large quantity of simple distilled water through it, and then to submit it to a temperature sufficiently high to sterilize it. He uses glass for filtering, which, besides retaining the suspended impurities as well as the paper, has the additional advantage of serving indefinitely. He suggests further that the containers should be of such a dimension as to insure rapid emptying.

Alteration of Iodoform Preparations.—When iodoform is dissolved in liquid cacao butter, and the mixture allowed to solidify, exposure to the light will soon cause a reddish coloration. H. Barnouvin, *Jour. de Pharm. et de Chim.*, March, 1893, p. 274, finds that while fluid preparations show this change even in the dark, solid iodoform preparations remain unaltered indefinitely if exposure to the light is avoided.

Benzoparacresol, analogous to *benzonaphthol-benzosol*, is prepared, according to M. Petit, by treating paracresol with sodium benzoate in the presence of oxychloride of phosphorus; it crystallizes from hot alcohol in beautiful crystals, having a slight ethereal odor, and a fusing point of 70–71°; insoluble in water, but very soluble in ether and chloroform.—*Jour. de Pharm. et de Chim.*, March, 1893, p. 294.

Purity of Zinc.—According to Lescoeur (*L'Union Pharm.*, Jan., 1893, p. 34), zinc, prepared by the double treatment of oxidation by potassium nitrate, and fusion with zinc chloride, is entirely free from arsenic, antimony, sulphur and phosphorus, while the iron, lead, copper, etc., which it still contains, present ordinarily no inconveniences. On the contrary, the presence of these metals facilitates the action of acids and the disengagement of hydrogen.

Cerberin is a glucoside obtained from a Mexican plant of the genus Thevetia, nat. ord. Apocynaceæ. It is a yellowish, amorphous, bitter powder, easily soluble in water and alcohol; the action of dilute sulphuric acid produces glucose and cerberesin. Dr. Zotos (thesis, Dorpat, 1892) shows its physiological effects on the heart, when administered hypodermically, to be analogous to those of the digitalis group.—*L'Union Pharm.*, Feb., 1893, p. 90.

Myrrholin is a solution of one part of myrrh in one of oil, and is said to have given good results in tuberculous laryngitis; it is administered in capsules containing 0·20 gm. of myrrholin and 0·30 gm. of creosote.—*L'Union Pharm.*, Feb., 1893, p. 95.

Resorcylalgin.—On mixing β-resorcylic acid and analgesin, a precipitate is formed which is soluble in alcohol and slightly so in water, and forms with the alkaline bases soluble salts (resorcinalginates). The ammonium salt is very soluble in water and has a saccharine taste.—A. Petit, in *Jour. de Pharm. et de Chim.*, March, 1893, p. 294.

For Chapped Hands.—The following formula is published in *Journ. de Pharm. et de Chim.*, March, 1893, p. 296. Green soap, 1 part; compound tincture of benzoin, 4 p.; glycerin, 8 p.; and rose water, 16 p.

Corn Cure.—The following formula will be found in *Journ. de Pharm. et de Chim.*, Feb., 1893, 248. Dissolve extract of Indian cannabis 1 part, salicylic acid 10, and turpentine 5, in collodion 82, and add 2 parts acetic acid.

*Translated for the American Journal of Pharmacy.

THE PHOTOGRAPHIC PROPERTIES OF THE CERIUM SALTS.

By MM. AUGUSTE and LOUIS LUMIERE.

WE know that cerium yields two principal series of salts. The former are very stable, while the ceric salts are brought back to the lower stage of oxidation even by feeble reducing agents. Some among them, more especially the organic salts, are even reduced spontaneously as soon as formed, so that hitherto it has not been found possible to isolate them.

The easy reductibility of the ceric salts has led us to study the action of light upon these substances, and we have been able to observe that this action effects a rapid reduction which may serve as a basis for the establishment of interesting photographic procedures.

Among the mineral salts which have yielded us the best results we may mention ceric sulphate and nitrate obtained by dissolving ceric hydroxide in sulphuric or nitric acids. The aqueous solutions of these salts have served to saturate sheets of paper, suitably sized and coated with a thin layer of gelatin, which the cerium salt colors an intense yellow. After drying in the dark, the papers were exposed to light under a positive proof. In all the transparent parts the luminous rays reduce the ceric salt to the cerous state, and the paper is decolorized at these parts. This progressive decoloration enables us to follow the action of the light and to stop the impression at the proper moment.

The proof when thus obtained must be treated with a reagent capable of differentiating the cerous from the ceric salt, so as to accentuate and fix the image. In an analogous process with the manganic salts, which we have formerly published (*Bulletin de la Soc. Francaise de Photographie*, p. 218, 1892), we used the striking oxidizing properties of the manganic salts to form insoluble coloring matters with a great number of substances of the aromatic series. In the same manner, if we treat the proofs with cerium salts with these reagents, we form and fix coloring matters at the points where the ceric salt has not been reduced by the light. It then suffices to eliminate, by washing, the excess of the reagent as well as the cerous salt to obtain a proof distinctly fixed. It is important that the coloring substance produced should be insoluble, so that it may not be carried away by the washing.

We found, on considering their photographic utilization, and on comparing the action of the ferric, cobaltic, manganic, and ceric salts upon a great number of substances of the aromatic series, that the ceric salts are capable of yielding colored reactions much more numerous than the salts of the other metals.

Among the most characteristic reactions we may mention the following:

In an acid solution the proofs are gray with phenol, green with aniline salts, blue with naphthylamine α, brown with amido-benzoic acid, red with parasulphanilic acid, green with the salts of orthotoluidine, etc. On treatment with ammonia the color changes; it becomes, for instance, violet with aniline, red with methylamine, etc.

Photographic papers prepared with cerium salts possess a much greater sensitiveness than that of the preparations with ferric or manganic salts.—*Comptes Rendus*, cxvi., p. 574; *Chem. News.*

THE ASSAY OF GOLD.

AT a recent meeting of the Chemical Society, London, the following papers were read:

"*The Limits of Accuracy of Gold Bullion Assaying, and the Losses of Gold Incidental to it.*" By T. K. Rose.

Some of the causes of the errors in the assay of gold bullion by the ordinary method are referred to, and it is shown that:

1. A higher degree of accuracy is attained if the weighings be made with the precautions recommended by Kohlrausch and others on a balance indicating differences of 0·01 per 1,000 (½ grm.), instead of 0·05 per 1,000, which is the smallest difference shown on ordinary assay balances.

2. Differences either in the amount of copper present to the extent of only 16 parts per 1,000 of alloy, or in the amount of silver added to the extent of 3 per cent., produce alterations in the "surcharge" of about 0·05 and 0·1 per 1,000 respectively, the "surcharge" being the difference in weight between the gold existent in the assay piece originally taken and the cornet finally obtained; it is the algebraical sum of the gold lost and the silver remaining undissolved by the acids. The reduction in the surcharge due to the presence of antimony, zinc, tellurium, iron, or nickel is also given.

It therefore follows that, in order to insure accuracy, check assays must be made on alloys of the same composition as those under examination.

3. The want of uniformity of temperature ordinarily prevailing in the muffle furnace during cupellation causes variations in the surcharge. The temperatures of the different parts of a muffle at the Royal Mint were taken during cupellation by a thermoelectric pyrometer—consisting of a platinum and rhodioplatinum couple—on three occasions, from which it appears that the mean temperature of the muffle was 1063·7°. At this temperature a rise of about 5° is found to be accompanied by a reduction in the surcharge of about 0·01 per 1,000.

If attention be paid to these points, the gold in bullion of a high degree of purity can be determined within a range of ±0·02 per 1,000, the limits of accuracy having been previously considered to be ±0·10 per 1,000. This extreme degree of accuracy is only possible if the check gold be pure.

In the second part of the paper the losses of gold in bullion assaying are estimated. They are due to (1) absorption by the cupel; (2) volatilization in the muffle; (3) dissolution in the parting acid.

The results of a number of assays are given, the gold having been in each case recovered from the cupels and acids, and, after the gold so recovered has been allowed for, the loss by volatilization is estimated by difference. The losses, in parts per 1,000, observed in the assay of standard gold (916·6 fine) were as in accompanying table.

A and B are means of four, and C a mean of three, determinations. Other results are also given.

	A.	B.	C.
In cupel	0·513	0·36	0·51
In first acid	?	0·01	0·03
In second acid	0·012	0·02	0·04
Volatilized	0·075	0·05	0·06
Total loss	0·600	0·44	0·64

The determination of the amount of gold volatilized is only approximate, as the result obtained represents the algebraical sum of the errors in several estimations added to the true amount. However, it probably usually lies between 0·5 and 0·1 per 1,000.

"*The Volatilization of Gold.*" By T. K. Rose.

The loss of gold involved in the fusion of the pure metal and its alloys was investigated by subjecting small test pieces of from 0·5 to 2 grms. in weight to a high temperature under varying conditions on bone ash cupels placed in a muffle. The work may be considered to be a continuation of the researches of James Napier (*Jour. Chem. Soc.*, x., 229; xi., 171). The temperatures varied from 1,045° to 1,300°, and were measured by either a platinum and rhodioplatinum couple or the optical pyrometer devised by M. Le Chatelier. The losses of gold could not be measured by the alteration of the mass of the test pieces in the muffle owing to absorption of gases, which sensibly augment the weight of the gold buttons. The true loss was found by assaying the buttons after fusion.

A considerable number of results are quoted. The chief points of interest to which attention is drawn are that:

1. An increase in the loss of gold takes place when the temperature is high, pure gold losing four times as much at 1,345° as at 1,090°.

2. A large amount of gold is volatilized in an atmosphere mainly consisting of carbonic oxide, while a small amount is lost in coal gas.

3. A comparatively small amount of gold is carried away by the more volatile metals, copper appearing to

exert an exceptional action; metals which are easily volatilized do not appear to be completely driven off by the highest temperatures attained in the experiments.

4. A large proportion of gold is lost in the case of alloys which form flat buttons on the cupel, and, conversely, a small proportion is lost from spherical ones, although the surface actually exposed is greater in the latter case than in the former. A current of air or gas passing over the buttons does not seem to increase the loss, provided the surface of the molten metal remain at rest. These results point to the conclusion that the conditions which lower the surface tension of the gold button simultaneously raise the vapor pressure of the gold.

DISCUSSION.

Professor Roberts-Austen said that, prior to the last few weeks, he should certainly have considered that the accuracy of an assay of gold was comprised within a range of ± 2/10,000. Mr. Rose had, however, tracked the errors to their respective sources, and had shown that a still higher degree of accuracy can be attained in ordinary work. It was not a little remarkable that although Princep (one of the best assay masters who ever held that important office) had clearly indicated in 1827 the importance of knowing the variations of temperature in an assay muffle, no one had attacked the problem until Mr. Rose took it in hand. Although questions connected with assaying did not often come before the society, they were matters to which the fathers of chemistry had given much attention. He might remind the society that, apart from their scientific interest, these minute questions connected with assaying assumed considerable industrial importance. During his connection with the mint, extending over more than twenty years, he had been responsible for the standard pureness of more than 600 tons of gold, the value of which was over 80 millions sterling. As regards the number of assays made, he and his two colleagues, the assistant assayers, had made in the past year no fewer than 30,000 assays of gold, and they had every reason to believe that their average accuracy was 1-10,000th part.

RUTHENIUM.

By A. JOLY.

OF the six metals forming the platinum group there are three (platinum, iridium, and palladium) the physical properties of which have been more particularly examined by H. Sainte-Claire Deville and Debray. I purpose completing the study of the metals of the groups as regards the three rarer metals, rhodium, osmium, and ruthenium.

This study has become possible for ruthenium in particular, of which I have prepared 3 kilos. in a state of purity. Further, thanks to the inexhaustible kindness of Mr. G. Matthey, I am at present operating on some 50 kilos. of residues from the preparation of iridium, which will enable me to obtain by a new method 10 kilos. of this rare metal. In order to bring the metal into a state comparable to that of the other platinum metals, I intend melting it in a large mass.

Ruthenium is, along with osmium, the most refractory of the platinum metals. Deville and Debray have only with much difficulty succeeded in melting some small globules with the oxyhydrogen blowpipe. During this operation we are incommoded by the oxidizability of the metal, which tends to be transformed into the volatile oxide RuO_4. It was evident *à priori* that one might easily succeed with the electric arc. With the electric installation at my disposal, I was able to fuse globules of from 1 to 3 grms. The particles thus obtained have been melted into reguli of from 25 to 30 grms.—thanks to the kindness of M. De Nerville, who placed a more powerful arc at my disposal.

By means of raising the metal suddenly to a temperature much above its melting point, the fusion is effected in a few moments, and the loss by volatilization is scarcely sensible. We scarcely perceive the characteristic odor of the peroxide, but while cooling it becomes covered with the blue bioxide. After remaining for a few moments in aqua regia, which attacks neither the metal nor the oxide, then in hydrofluoric acid, and a final reduction in hydrogen, the metal is laid bare. By its gray color it approximates to iron rather than platinum. Its structure is crystalline, and hence it is brittle in the cold. If heated to redness in the flame of the oxyhydrogen blowpipe, it may be flattened out and then breaks. Further, the metal spirts strongly at the moment of solidification, and the globules are almost always full of cavities.

The specific gravity of the metal melted and pulverized is at 0°, and referred to water at 4° = 12·063, the metal being the same which had served for the determination of the atomic weight (*Comptes Rendus*, cviii., 946). For the same sample not fused M. Violle found the specific gravity 12·002. In the same apparatus and under the same conditions of temperature, the fusion of ruthenium is more difficult than that of rhodium, which, in turn, is melted with rather more difficulty than platinum; it is remarkably harder to melt than iridium (1950°).

As for the exact melting point, M. Violle, whose beautiful researches on the measurement of high temperatures are well known, has undertaken its determination. In the conditions at which ruthenium melts, osmium is merely agglomerated and fritted. Iridium osmide, which cannot be melted with the oxyhydrogen blowpipe, is melted with great difficulty into a white crystalline mass, which the best tempered tools do not succeed in cutting.—*Comptes Rendus*, cxvi., p. 430; *Chem. News*.

OXIDIZING AND DECOLORIZING ACTION OF CHARCOAL.—Cazeneuve (*Pharm. Central Halle*).—As far back as 1874 A. W. Von Hofmann observed that charcoal—especially animal charcoal—can exert a strong oxidizing action. An alcoholic solution of leukaniline quickly yields rosaniline if boiled with animal charcoal. Cazeneuve made similar observations on boiling aqueous solutions of *a*-naphthylamine or of paraphenylendiamine with animal charcoal; the first mentioned becomes a purple red and the second a brown. The charcoal retains the color firmly, but yields it up again to boiling alcohol. The idea that the oxidizing action of carbon was concerned in the decolorizing action was at once suggested. On experiments made for this purpose it was found that charcoal which had been previously ignited and cooled in a current of dry nitrogen or in carbon dioxide had less decolorizing power than such as has been cooled in the air. Cazeneuve is of opinion that the residual oxygen in the charcoal burns the coloring matter.

BOTTLE WAX.

RUNDSCHAU gives the following directions for making cheap waxes for bottling: *Blue*—Melt 1,000 parts of clear brown colored resin, and add to it 12 parts of cinnabar, rubbed down fine with 8 parts of cottonseed oil, then 15 parts of zinc white, and 85 parts of ultramarine blue, mixed with 12 parts of cottonseed oil. *Red*—Clear brown resin 100 parts, tallow 25 parts; melt and add a mixture of cinnabar, 8 parts, and refined resin oil 6 parts. *Yellow*—Clear brown resin 200 parts, tallow 20 parts, chrome yellow 12 parts, prepared chalk in fine powder 2 parts, resin oil 6 parts; prepare in the same way as the red. *Green*—Clear brown resin 200 parts, tallow 20 parts, Bremer blue 6 parts, ocher 6 parts, prepared chalk in fine powder 2 parts, refined resin oil 3 parts.

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